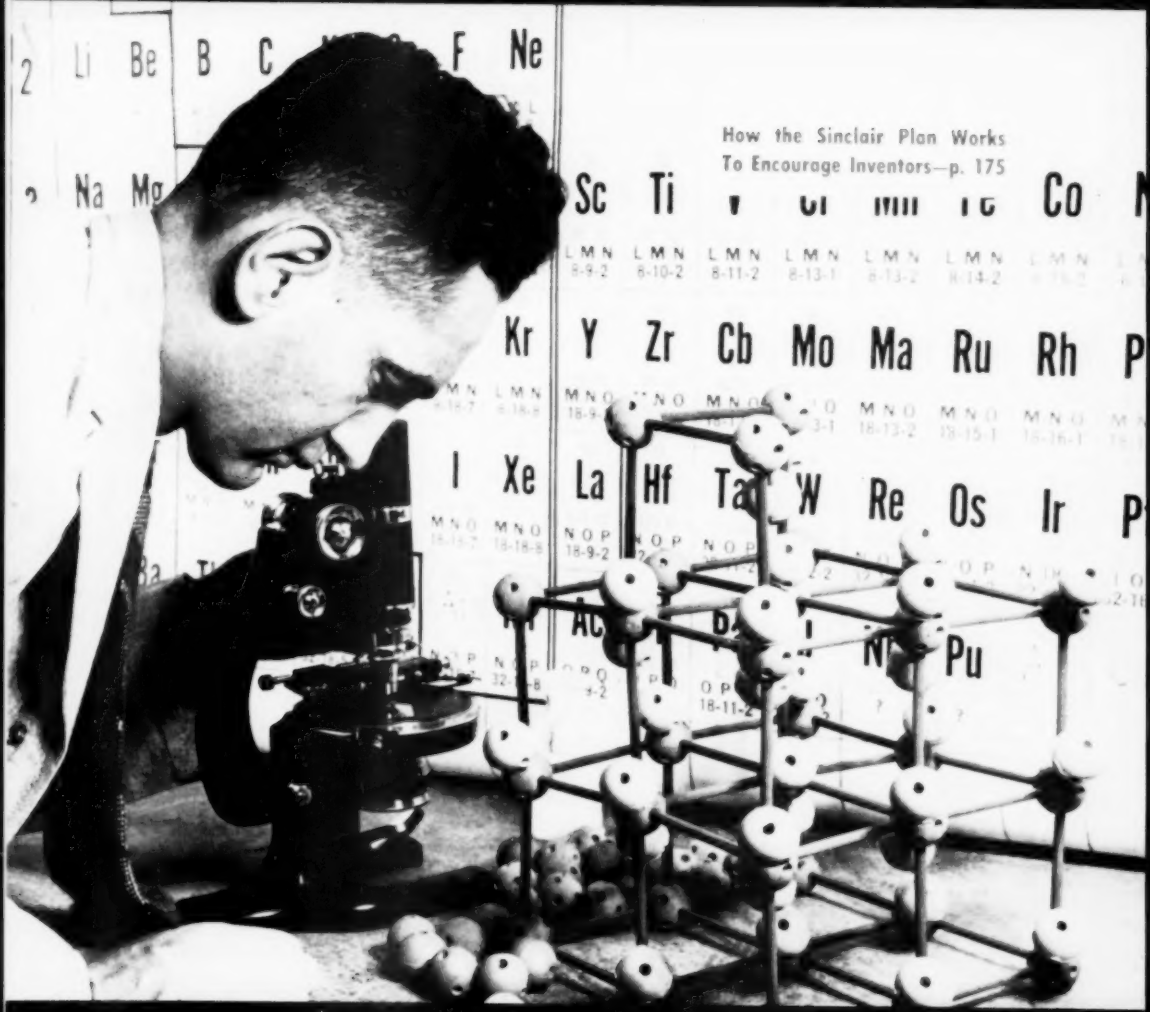
FEBRUARY, 1952
VOL. 7, NO. 2

PETROLEUM PROCESSING



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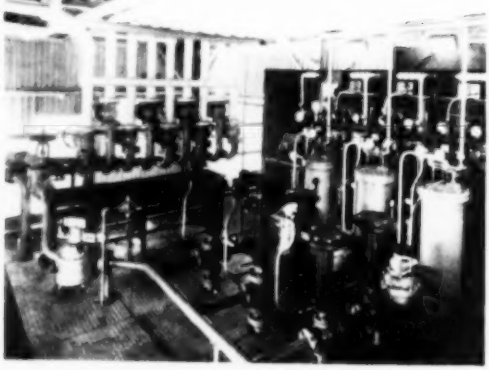
HEART of streamlined processing, this %Proportioneers, Inc.% Continuous, Automatic Blender combines base stocks and additives. It provides new speed, flexibility and economy in the production of uniform blends. The system reduces manpower, eliminates blending tanks, agitation, auxiliary pumps and attendant piping. Because the finished product is immediately available, tank trucks can be loaded without waiting. The %Proportioneers, Inc.% Continuous, Automatic Blender, preset to formula, controls component ratios and permits quick adjustment of output to suit demand rates. This installation at refinery of Richfield Oil Corporation at Watson, Calif., delivers a variety of finished products, exactly to formula, to trucks and/or storage tanks.



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A safety record is no accident

Setting a record is no easy job, but it's well worth the effort—especially when safety is involved.

We are proud of the part we have played in the oil industry's safety record. We are particularly proud that the system of safety precautions for the handling and mixing of "Ethyl" antiknock compound and the safe practices in tank-cleaning techniques which have been accepted and put into effect throughout the industry were pioneered by Ethyl safety engineers.

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Continued on next page

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

A safety record is no accident

Continued from preceding page

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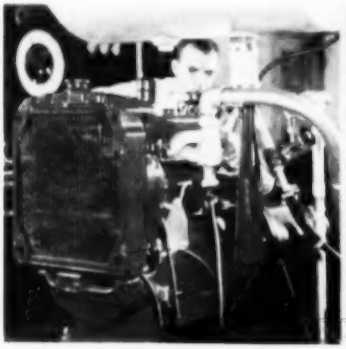

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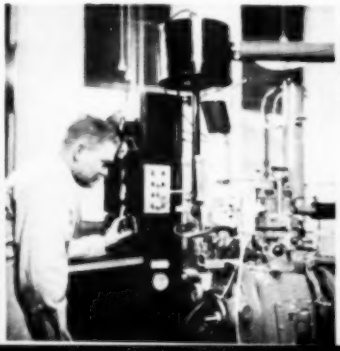

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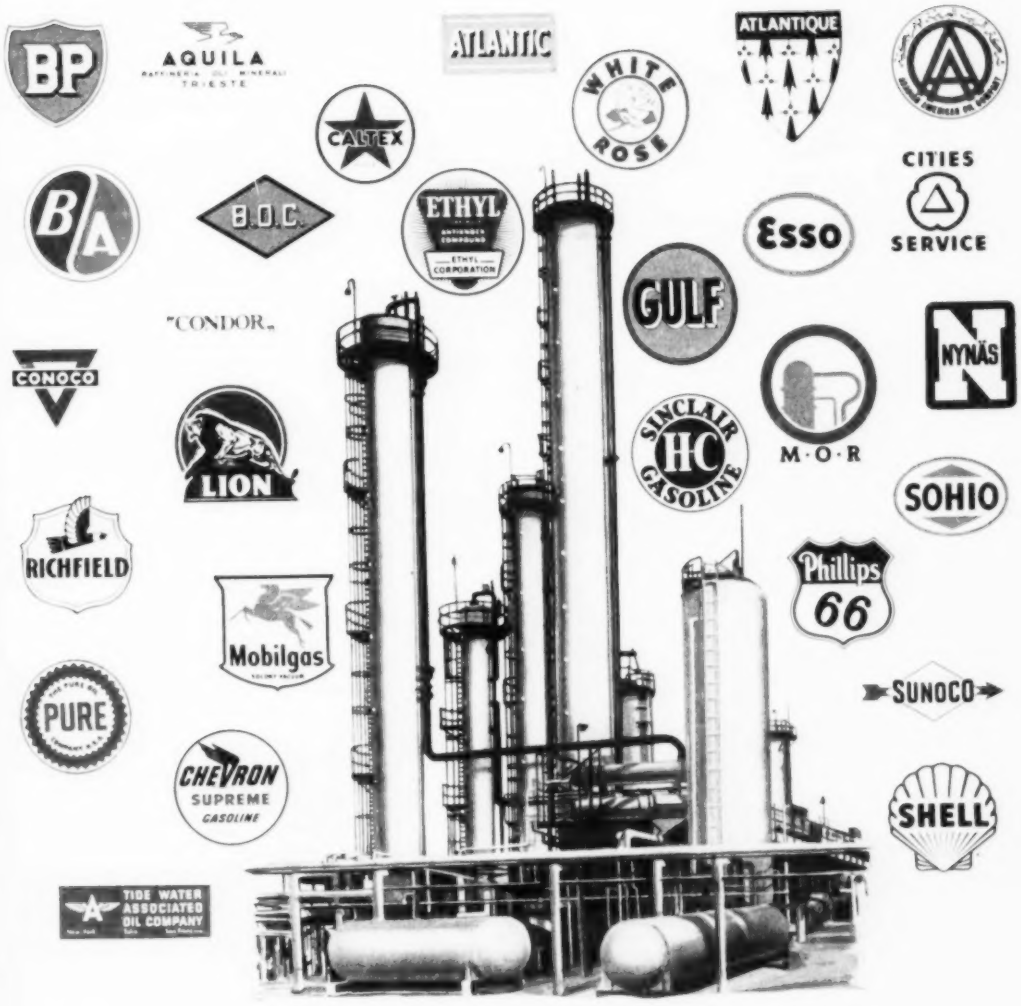

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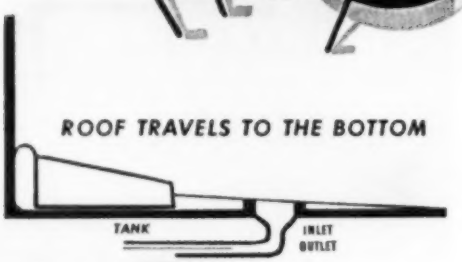

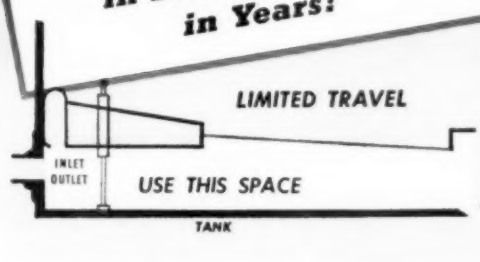

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Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

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Platt's Oilgram News and Platt's Oilgram Prices
A daily independent oil-news and oil-price reporting service issued from New York, Cleveland, Houston

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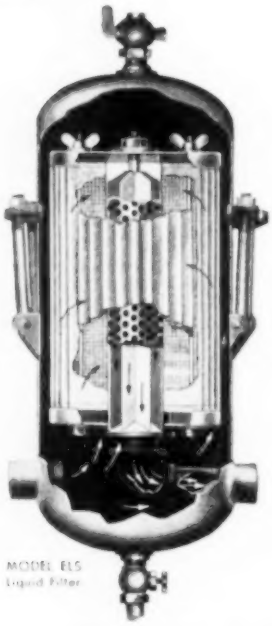
"STAYNEW LIQUID FILTERS KEEP US OUT!"



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No matter how complex your filtration problem, look to Staynew for the answer. The Dollinger Corporation maintains a fully equipped research laboratory to design filters for any type of liquid filtration.

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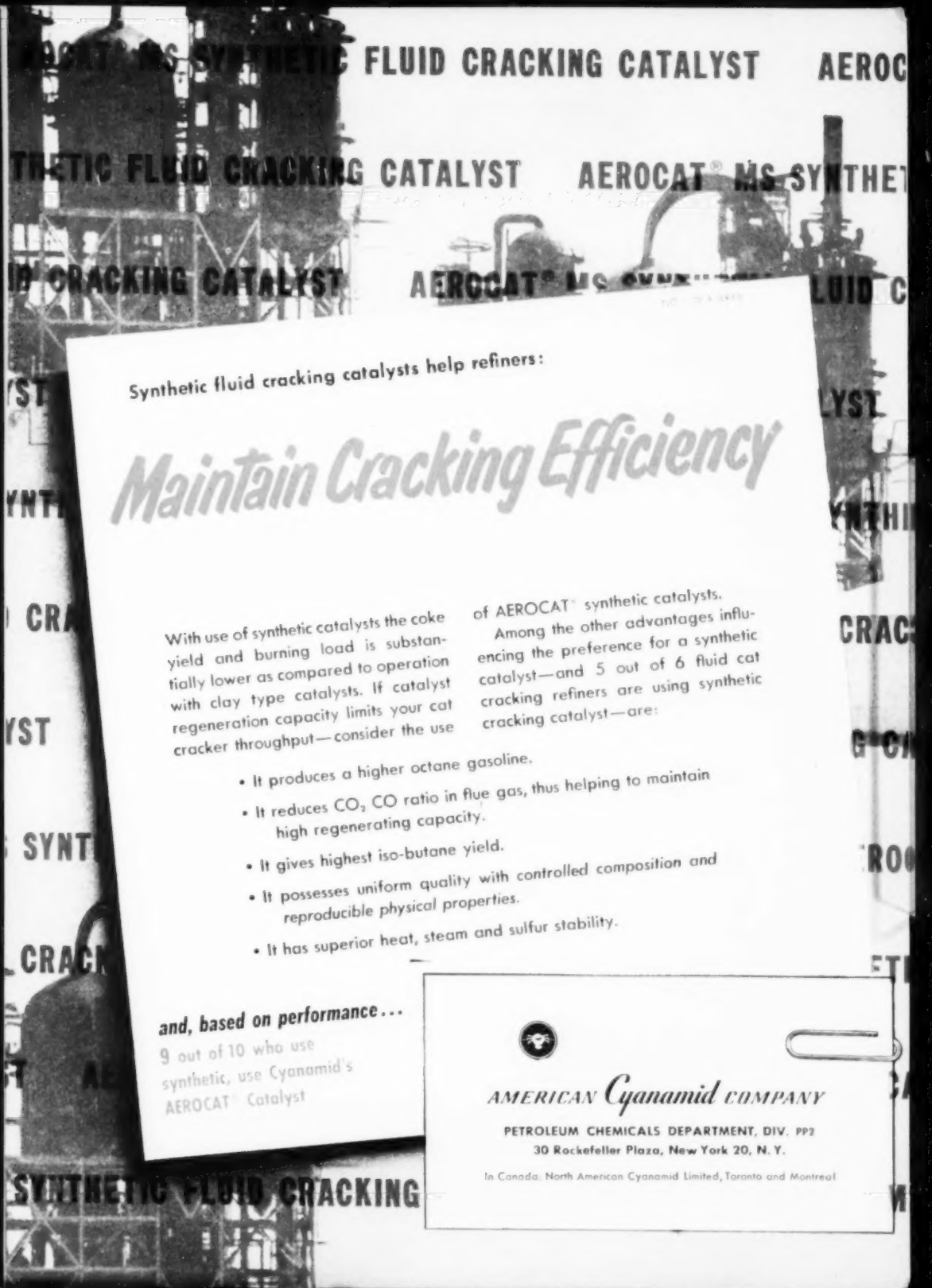

Synthetic fluid cracking catalysts help refiners:

Maintain Cracking Efficiency

With use of synthetic catalysts the coke yield and burning load is substantially lower as compared to operation with clay type catalysts. If catalyst regeneration capacity limits your cat cracker throughput—consider the use of AEROCAT® synthetic catalysts.

Among the other advantages influencing the preference for a synthetic catalyst—and 5 out of 6 fluid cat cracking refiners are using synthetic cracking catalyst—are:

- It produces a higher octane gasoline.
- It reduces CO_2 CO ratio in flue gas, thus helping to maintain high regenerating capacity.
- It gives highest iso-butane yield.
- It possesses uniform quality with controlled composition and reproducible physical properties.
- It has superior heat, steam and sulfur stability.

and, based on performance...

9 out of 10 who use synthetic, use Cyanamid's AEROCAT® Catalyst

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3 Precision Controls for All Speed Problems

Here's governor standardization that "pays off". Now you can economically solve all speed-control problems with only three basic governors.

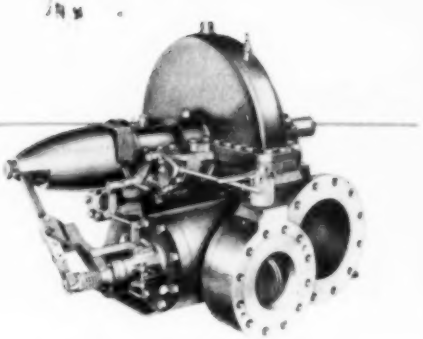
Costly special engineering is eliminated. Advanced design gives an unusual degree of flexibility . . . with precise speed control for all steam conditions. Results? Initial costs are lower . . . shipments are quicker . . . spare-parts inventory is reduced.

Designs for three basic classes of steam conditions, three wheel sizes, and three types of governors provide, in effect, twenty-seven standard variations to cover a wide range of applications. All oil-governed, direct-connected Type E units include the standard reservoir-type base, as illustrated. What's more, Type E governors can meet a great number of special requirements with optional accessories. This standardization results directly from Westinghouse's wide experience in all industry.

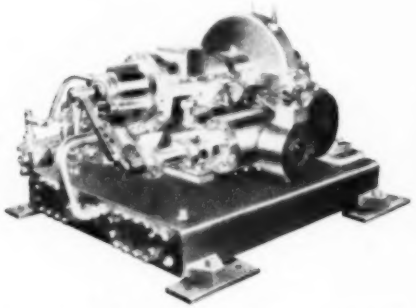
Other outstanding maintenance-saving features on the Type E turbine are Dual Protection . . . Weather Protection . . . Centerline Support . . . and a Rugged Governor Housing. Ratings are available from 5 to 1,500 hp.

For complete information ask your nearby Westinghouse representative for Type E Turbine Book J50527, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

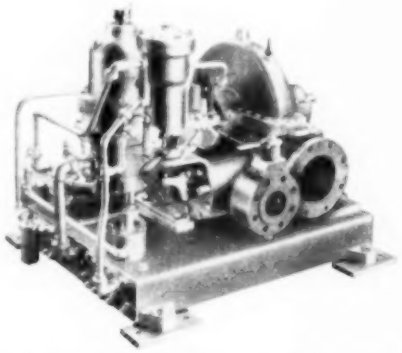
YOU CAN BE SURE.. IF IT'S
Westinghouse
Turbines



Shaft-Type Governor. For narrow speed-range applications, this governor automatically positions the steam admission valve to control turbine speed within close limits—*6 to 8% speed regulation*



Hydraulic-Orifice Governor. For wide speed-range applications such as drives for fans, blowers, and compressors —*4-to-1 speed-adjustment range; 6% speed regulation.*



Vertical Oil-Relay Governor. For narrow-range precision-control applications such as drives for generators, pumps, blowers and compressors—*33⅓% speed-adjustment range; 4% speed regulation.*

J-50527

WHAT'S HAPPENING

Current News Summarized For Oil Men

Expansion

Expansion of domestic refining capacity at annual rate of 475,000 b/d for 18-month period beginning July 1, 1952, is being recommended by Petroleum Administration for Defense. Program does not attempt to provide capacities which would be required in an all-out war, but aims only at meeting increased demands under present conditions and at adding some margin of safety for emergencies.

Added capacity would boost total U.S. capacity figure to over 8,100,000 b/d by end of '53. Cost is estimated at $1.3 billion.

Additional natural gasoline capacity is also included in program—131,000 b/d during same 18-month period, at cost of about $200 million.

Standard Oil Co. (Ind.) plans to build a new 15,000 b/d refinery in N. Dakota, with plant designed to permit expansion to at least 30,000 b/d. Engineering work has been started, but a definite site has not been selected and construction probably won't get under way until '53. Reason given for expansion in that area is that Indiana Standard considers Williston basin such a promising source of crude.

Williston Refining Co., a new firm, also plans to build in N. Dakota—either at Minot or Williston. Company is headed by James P. Dunnigan, of Producers Refining, Inc., West Branch, Mich. Preliminary plans call for 10,000 b/d plant.

Socony-Vacuum Oil Co. is planning a $27 million construction program to build three new TCR (Thermofor Catalytic Reforming) units. They are planned for Socony's plant at Augusta, Kan., and subsidiaries' plants at Torrance, Calif. (General Petroleum) and Beaumont, Texas (Magnolia Petroleum), to process a total of 37,000 b/d.

The Texas Co. has received DPA approval of $27,750,000 project to build avgas facilities at its Amarillo, Texas, refinery. Crude capacity will be increased 7000 b/d, to 15,500 b/d; avgas 830 b/d, with production of 470 b/d LPG. Motor gasoline volume will be virtually doubled, distillates and coke proportionately increased.

Pure Oil Co. will build a 17,000 b/d Orthoflow Fluid catalytic cracking unit, with gas recovery, catalytic polymerization and sulfur removal facilities, at its Toledo, Ohio, refinery. This is in addition to the "more than 26,000 b/d" Orthoflow announced for its Smith's Bluff (Nederland), Texas refinery (What's Happening, Nov., 1951, p. 1187). Also slated at Smith's Bluff is 20,000 b/d vacuum feed preparation unit, revamped thermal cracking, catalytic polymerization and sulfur removal facilities. M. W. Kellogg Co. has both contracts; completions spring of '53.

El Dorado Refining Co. is increasing capacity of its El Dorado, Kans., refinery from present 9000 b/d to a minimum of 10,000 and maximum of 15,000 b/d in a $3 million modernization program which calls for a 4300 b/d Fluid cracking unit and revamping crude distillation. Refinery Engineering Co. has contract with expected completion by January, 1953.

Vickers Petroleum Co., Inc. is doubling capacity of its 5000 b/d Potwin, Kans., refinery by adding crude stills and installation of a 6000 b/d packaged Thermofor cracking unit. Southwestern Engineering Co. has the plant expansion contract with completion scheduled for Jan. 1, 1953.

Western Reserve Refining Co. is increasing size of its 2200 b/d Niles, O., refinery to 6000 b/d with a new skimming unit. Catalytic Construction Co. has contract with completion expected by March 1.

Imperial Oil Co. Ltd. will install a 7500 b/d Fluid catalytic cracking unit at its Vancouver, B. C., refinery in addition to vacuum and atmospheric distillation units and gas recovery facilities as part of $13,500,000 program to expand plant to 22,500 b/d capacity. (See What's Happening, January, 1952, p. 7.) Most of existing process units will be replaced.

Southwestern Oil & Refining Co. has let contract to Refinery Engineering Co. for modernization of its plant at Corpus Christi, Texas (see What's Happening, July '51, p. 691).

Ashland Oil & Refining Co. reports construction has started on $5 million expansion and modernization of its Buffalo refinery (formerly Frontier Oil Refining Corp.) to add catalytic cracking and boost crude throughput. At its Catlettsburg, Ky., refinery program is under way to increase catalytic cracking capacity to 27,000 b/d, double existing vacuum distillation, provide for aviation alkylate and permit overall increase in crude throughput. At Canton, O., construction is virtually complete and operation of new facilities for catalytic cracking and a 40% increase in crude throughput is expected early in 1952.

Petrochemicals

Hercules Powder Co. is planning its first venture into the petrochemical field with a new $8 million plant to be built near Wilmington, Del., and scheduled for completion in 1953. It will use propylene and benzene as raw materials for making phenol and acetone

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

via a new oxidation process developed by Hercules (same as B. A. Shawinigan in Montreal will use—see What's Happening, Dec. '51, p. 1316, and July '51, p. 69). Plant will also make para-cresol and cyclene alcohols from terpenes from Hercules naval stores operations in Georgia and Mississippi.

Carbide and Carbon Chemicals Corp. is building a major unit for producing polyethylene resins at its Texas City, Texas plant. It is expected to be in operation by early '53, and will have an estimated capacity of 50,000,000 lbs. of polyethylene annually. Total U.S. annual production of this material this year is expected to be between 100 and 150 million lbs.

Cities Service Co., through its subsidiaries, is developing plans for the utilization of natural and refinery gases in manufacturing a broad range of plastics, synthetic rubber, lubricant additives, anti-freeze, ammonium nitrate and "many high-volume petrochemicals." It will make "substantial" capital investments also in refining operations, marketing, and the like.

Monsanto Chemical Co. is planning a 250-ton sulfuric acid plant at Avon, Calif., which will utilize waste sludge and hydrogen sulfide piped from adjacent Tide Water Associated refinery. Plant will use Monsanto-Ross-Wilde process, and is expected to be in operation by end of '52. It will be owned jointly by Tide Water and Monsanto, but is being designed and will be operated by Monsanto. Leonard Construction Co. will handle construction.

Gulf Oil Corp. will install a new catalytic (phosphoric acid) polymerization unit at its Port Arthur, Texas, refinery primarily to make high octane gasoline from propylene but also high polymers for sale as petrochemical intermediates. Bechtel Corp. has the contract. Also a 300 ton per day sulfuric acid plant using the Monsanto-Ross Wilde sludge-decomposing and contact processes will be built by Leonard Construction Co., increasing acid-making capacity by 150%. Construction is expected to begin in three months with completion this year.

Shell Chemical Co. has upped synthetic glycerine output by 50%, and ethyl chloride output by 30%, with recent completion of new processing units at its Houston plant. Glycerine project is estimated to have cost about $1,500,000.

Phenol production capacity of 623,000,000 lbs. annually by the end of '54 is being sought by Defense Production Administration. Capacity as of Jan. 1 was reported at 343,600,000 lbs. per year.

Markets, Prices

January was a big month for fuel oils, with inventories of lighter grade (kerosine and No. 2) dropping a record-breaking 22,000,000 bbls. for the country as a whole from Dec. 29 to Jan. 26, according to API statistics.

Volume moving out of Mid-Continent and from Midwest plants, however, was not consistently heavy enough over the month to sop up production there of either light or heavy oils, and prices were easy. Trade sources told of "discounts" of as much as 0.5c per gal. (from generally quoted prices) on the lighter fuels. Near the end of January heavy fuel quotations dropped 10c to low of $1.55 per bbl., Group 3.

In other primary supply markets, especially Gulf Coast and Atlantic Seaboard, the picture was diametrically the opposite of Mid-Continent situation.

At the Gulf, gasoline was the only product available in quantity, but even with this product there was no tendency to shade prices. Demand for heavy fuel was such that large quantities were purchased in the Mid-Continent for shipment to the Gulf—some estimates ran as high as 3,000,000 bbls. over 1952.

Along the Atlantic Seaboard, generally tight markets in all terminal districts were the rule. Whereas kerosine and No. 2 were available at 0.5c "discounts" in the Mid-Continent, eastern barge buyers were bidding 0.5c "premium" (over low quoted prices) in an effort to supplement their contract commitments.

Price wars continued to plague the East, and a new one cropped up in Detroit. Philadelphia tank wagon prices were down 4c from the end of December, and were 5.3c below "normal." In New Jersey, retail prices were off as much as 8c for some major brands, even more for some private ones. Detroit prices, as this is being written, had dropped 2.5c a gal. in less than a week. Chicago gasoline price war, in meantime, cleared up, with retail postings advancing 7 to 7.5c, back to so-called "normal."

Industrial Mobilization

Defense Production Administration has again postponed—this time indefinitely—promulgation of new requirements that projects seeking rapid tax amortization must be approved by DPA prior to start of construction.

Steel allotment for refining branch of petroleum for 2nd quarter has been set at 158,472 tons, up approximately 8,000 tons from 1st quarter allotment. Natural gas processing gets 61,143 tons, up over 10,000 tons from 1st quarter.

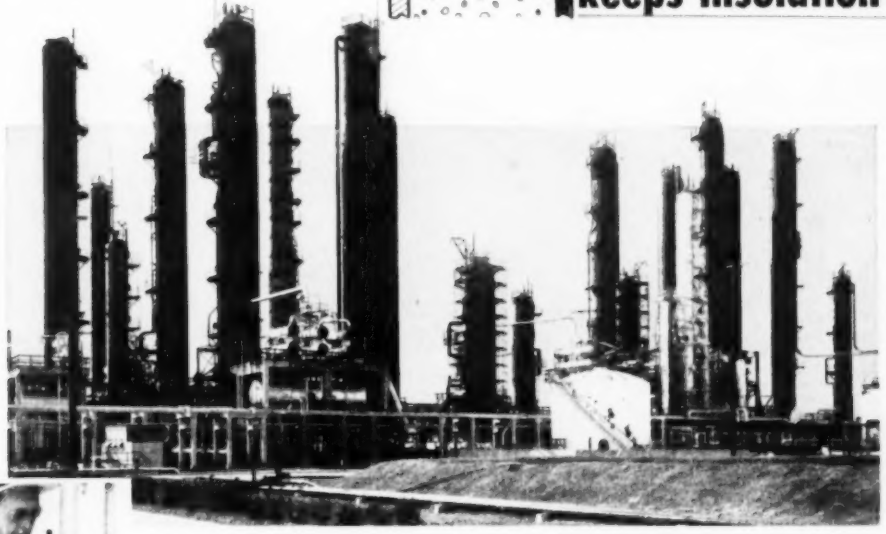
No relaxation in TEL use is expected following expiration of current order Feb. 29, although metallic lead picture itself has improved in past month. Deputy PAD Brown on Jan. 25 reported controls cannot be eased until we have a "much bigger" TEL national defense stockpile.

APPOINTMENTS—Maurice F. Granville (The Texas Co.), as Asst. Director of PAD's Refining Division, succeeding **Thomas L. Apjohn,** who is returning to Socony-Vacuum . . . **G. L. Glespen** (American Cyanamid), as chief of Chemicals, Containers and Packaging Branch, PAD's Materials Division, succeeding **Theodore H. Herman, Jr.,** who is remaining on PAD staff for time being as a consultant.

Transition

Socony-Vacuum Oil Co. has withdrawn from the candle-making business. Facilities for this operation at the company's Paulsboro, N. J., refinery have been sold to Will & Baumer Candle Co., Syracuse, N. Y.

INSUL-MASTIC vapor barrier keeps insulation dry



Here's what happens when insulation is improperly coated. This became watersoaked. The resultant rust still clings to it.

Inadequately weatherproofed insulation leads to trouble . . . trouble that can be averted by Insul-Mastic Coatings.

In more and more industrial plants, engineers are replacing their watersoaked insulation . . . using non-absorbent Insul-Mastic Type "D" . . . and in places where more insulation is required, new, dry conventional insulation is being protected with Insul-Mastic vaporseal and glass membrane.

Recently in a large plant the steel shells of huge fractionation towers were very badly rusted and pitted because of watersoaked insulation. An inferior coating over the insulation had permitted moisture and rain to penetrate. To prevent further damage to the shells, the insulation had to be removed.

Where temperatures did not exceed 225° F., Insul-Mastic Type "D", the spray applied cork filled, non-absorbent insulation, was applied. Where temperatures exceeded this figure, standard thermal insulation was applied and sealed with Insul-Mastic vaporseal and glass membrane.

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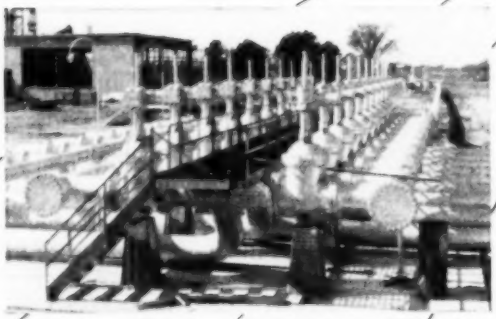

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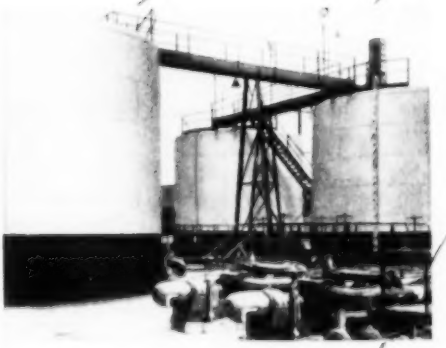

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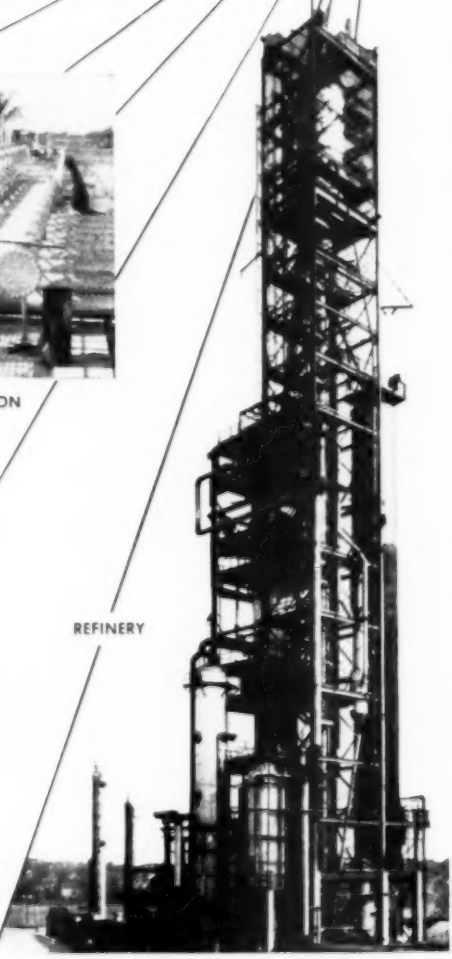

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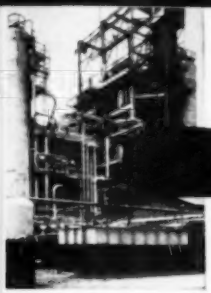

TOMORROW... IN PETROLEUM TECHNOLOGY

Possible Effects of Today's Developments On Future Operations

By the Editors of Petroleum Processing

Petrochemical "Krillium" Is First Synthetic Soil Conditioner

PETROCHEMISTRY and human curiosity have together cooked up another new compound which promises wide usage in commercial agriculture as well as the working-man's garden and milady's flowerbox. Called "Krillium," it is the first synthetic soil-conditioning chemical. The chemist describes it as the sodium salt of hydrolyzed polyacrylonitrile; sodium polyacrylate for short. Announced by Monsanto Chemical Co. after an interrupted 12-year search,[1] the principal raw material, acrylonitrile, will come from the company's newest plant at Texas City, Texas, now under construction.

Acrylonitrile, a petroleum chemical, first came into prominence during World War II in the manufacture of Buna N synthetic rubber; it also is a component of various synthetic textile fabrics. The starting product is ethylene, converted to the chlorohydrin with hypochlorous acid, thence to the oxide with caustic alkali and finally reacted with prussic (hydrocyanic) acid to the nitrile.

Apparently Krillium results from the polymerization of the nitrile and then hydrolysis in the presence of caustic soda.[2] It reportedly will be made at Monsanto's Springfield, Mass., plant. Substantial quantities likely will not be available until 1953.

Krillium's action is not clear, but it apparently is a substitute for the natural materials, polysaccaride or polyuronide resins, which come from decomposition of composts, peat moss and manures.[3] These stabilize soil aggregates, preventing leaching of clays, etc., and minimize erosion, forming groups of soil substances together into a single mass. The size of the Krillium molecule is not known, but is estimated in excess of 50,000 average molecular weight. It definitely is not a fertilizer, is resistant to decomposition from soil-bacteria attack and is not believed to be taken up by plants.

Since it stabilizes the soil, plant growth is stimulated by permitting increased aeration and better soil workability.[3, 4] Because it increases adsorption of water into the soil (it is itself adsorbed) and prevents erosion by slacking of clays, it has promise along highway grades, on footpaths, ball-parks, golf courses and potentially in flood-control by reducing run-off water. It may increase filtration rates through clays, such as in sewage disposal and possibly will have other industrial uses. Potentialities in land reclamation are very great.

A bad feature is the high cost—around $2 per lb. However, offsetting this is the fact that one pound of Krillium is equivalent to 200 lbs. of peat moss, 500 lbs. of commercial compost; also, it will last longer. In achieving soil aggregation only 0.02% concentration is required (200 lbs. per acre, treating top 3 in. of soil), with better results obtainable at around 0.05%, in soils tested, although 0.10% by weight can be used. Above 0.2% the effects are expected to be detrimental. It may be applied topically by dusting to stabilize soil against erosion and run-off water. For soil treatment Krillium may be added by working it into the soil along with some water, and there seems to be no ill effects by mixing it in fertilizers. Effects are noted within 24 hours. Monsanto scientists warn, however, that caution be observed in mixing Krillium with ammonium nitrate fertilizers because it is possible the combination might be explosive.

Approximately 80 different groups are cooperating with Monsanto in tests to learn more about Krillium applications. Until the Texas City plant comes in it is unlikely Krillium production will exceed 20,000 lbs. per month; thereafter enough acrylonitrile will be available to make 20 to 30 million lbs. annually should the market justify. Commercial marketing likely will be in the form of packaged formulations for specific uses. —D.P.T.

(1) C. A. Thomas, C. A. Hochwalt, et al., "Symposium on Soil Structure," Am. Assoc. for Advancement of Science, Philadelphia, Dec. 26-31, 1951.
(2) Anon., "Creeping Up on Nature," Chemical Week, Jan. 5, 1952, p. 31-33.
(3) Anon., "Synthetic Polyelectrolyte Improves Soil Structure, Prevents Erosion," Chemical & Engineering News, Dec. 31, 1951, p. 5240-41.
(4) W. L. Lawrence, "Synthetic Restores Soil Productivity In Hours Instead of Usual Years," New York Times, p. 1, Dec. 30, 1951.

Simple Pulsator Reduces Stages In Liquid-Liquid Extraction

A NEW wrinkle in the field of liquid-liquid extraction is suggested by two Cornell University chemical engineering professors in the development of a very simple method for mechanically agitating the contents of a column by pulsation. It is said to increase the number of extraction stages for a given packed column as much as 80% without use of paddles, disks or shaking the column.[1] This method differs from a technique suggested last year, which proposed to give the molecules a "colossal shaking" by applying supersonic energy.[2] This latter method is not reported to have been used commercially although several oil companies are said to be interested from the research angle.

The Cornell pulsation method has been developed by Robert Von Berg and Herbert Weigant, using a 1¼-in. diameter glass column packed with ¼-in. Raschig rings. Pulsations were applied to the fluid in the column with an ordinary automotive-type diaphragm fuel pump, using the system methyl isobutyl ketone-acetic acid-water to determine results. Control tests were run without pulsation for comparison.

In a typical run with the control column the height of a theoretical extraction stage was 7.8 in. Using a 74 cycle per minute pulse rate and an amplitude of ¼ in., the stage height was 1.6 in., a drop of 80%. The packing was not disturbed and phase separation of the liquids was unaffected. Other studies indicate the feed and pulsator pumps should be separate, although the pulsator may either be connected to the feed line or the bottom of the column. Apparently

the maximum amplitude in commercial equipment should not exceed ½ to ¾ in. Power requirement is obviously low.

A number of possibilities in the extraction field are apparent in this development. There are some practical disadvantages, as well, however; disturbances to instrumentation, particularly flowmeters, could be expected because of the pulsations. On the other side of the ledger, however, are reduced column height for a given number of stages or vice-versa and application to an existing column by the installation of a low capacity variable speed reciprocating pump with provision for adjusting the stroke.

Subject to experimental confirmation it is likely, however, that the method would show greater effectiveness with packed towers than with bubble types because of the greater wetted surface presented by the former. The expense probably would not be justified in the case of "easy" extractions (few stages). In systems where emulsification already is a problem the method is likely not feasible.

Potential applications in refining would appear to be solvent extraction of sulfur compounds from light fuels, such as gasoline, and in the refining of lubricating oils (with due regard to emulsification possibilities). Numerous applications in the petrochemical field also present themselves. —D.P.T.

(1) "Extraction With a Beat," Chemical Week, Dec. 15, 1951, p. 32.
(2) Pitt, W. C., "Application of Ultrasonic Energy Practice in Chemical Processing," Petroleum Processing, Jan. 1950, p. 70.

Progress Reported in "PB" and "Alfin-Type" Synthetic Rubbers

TWO developments in synthetic rubber manufacture are worth watching as time goes on, both aimed at increasing supplies of this vital material without requiring added plant capacity. One is the development of polybutadiene ("PB") synthetic by Phillips Petroleum Co. ("Tomorrow in Petroleum Technology," July '50, p. 694). The other is further investigation of oil-extended "alfin-type" GR-S.

Phillips announced its polybutadiene development in June '50. Worked out under government-sponsored research, it was one of the few polybutadiene synthetic rubbers ever to be considered worth road-testing. On the basis of early performances in actual tires the new "PB" looked about as good as "cold rubber," itself then still relatively new. While "PB" rubber has made considerable progress in the past year, Phillips reports that the product is not yet fully established as a standard readily available material.(1)

In part the slow development is said to have come from the reluctance of RFC's Synthetic Rubber Division to stimulate new products development on the grounds that this work interferes to some extent with maximum production of already-standard types.

In the field of oil-extended "alfin-type" GR-S, Goodyear Tire & Rubber Co. and the government rubber laboratories at the University of Akron have developed a new way of making a high viscosity (Mooney number) product.(2) Although it is a butadiene-styrene copolymer, polymerization is carried out in a non-aqueous solvent (e.g., pentane) instead of the usual aqueous solution containing various modifiers. The oil extender is added to the non-aqueous solution, proportionately reducing the amount of modifier required and largely replacing the solvent otherwise needed. The catalysts, too, differ from those ordinarily used, and give the new rubber its name. These are "alfins," the name developing from the fact they are complex organo-sodium compounds comprising mixtures of sodium alkoxide and sodium olefins.

Still ahead before commercial use becomes accomplished fact are proving the pudding in extensive road testing, which will require pilot plant production of the rubber in sufficient quantities; working out of a successful commercial procedure; and development of a safe and commercially-feasible process for manufacturing the catalysts in large quantities. A bust in any one of these could relegate "alfin-type" GR-S to the shelf. —D.P.T.

(1) Private communication, Phillips Petroleum Co., Jan. 14, '52.
(2) "New Oil-Extended Rubber Has Commercial Possibilities," Chem. & Engr. News, Nov. 26, '51, p. 5068.

Petroleum Leads Way in Showing Economy Possible by Standardizing

STANDARDIZATION as a means for effecting substantial savings in construction, operation, and maintenance costs has apparently long been recognized by the petroleum processing industry, a recent survey by the American Standards Association reports.(1) In fact, the petroleum industry has been a leader in the standards movement, this survey of 140 case studies in 81 different industries brings out.

The value of standardization was brought home to manufacturers thoroughly during the recent emergencies—World War II and the present "partial" mobilization. That it will continue to grow in value there is little doubt. More and more companies are recognizing this value and are taking advantage of it, the ASA survey shows. Actual savings in dollars or in percentage figures vary widely. In most cases where definitely reported, they are indeed impressive. One difficulty in estimating savings accurately is the lack of proper cost accounting records, procedures, or personnel.

How are the savings realized among companies already using standardization? The survey analysis shows that 75% of the cases derive savings from reduced inventories of materials, parts, and end products. Nearly the same number (72%) listed as important sources of savings: 1) purchasing "larger quantities of fewer items," and 2) the use in engineering of "accepted standard specifications" instead of special specifications and "tailor-made" raw materials and equipment.

A necessary word of caution is brought out in the ASA summary: Adoption of standards for any item—a material, a test, a procedure, or a product—necessitates the elimination of all "non-standard" varieties of the item. This problem has perhaps been most vividly demonstrated in this magazine's recent series of articles on equipment buying practices in the petroleum processing industry.(2) Though a leader in standardization, particularly on the development of equipment specifications, this industry should now make progress also toward elimination, or at least reduction, of "non-standardization." —W.C.T.

(1) "Dollar Savings through Standards," American Standards Association, Inc. (Copies may be obtained at $1.00 each from the ASA, 70 East 45th St., New York 17, N. Y.)
(2) Series of articles on "How to Order Equipment," by David P. Thornton, Jr., Petroleum Processing, July through Dec., 1951.

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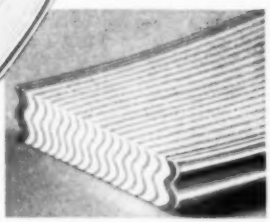

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LETTERS

Synthetic Fuels

Mr. Ayres hits the nail on the head when he forecasts a new interrelation of corporate activities in the future to produce fuel and electric power when the time arrives that our petroleum supply fails to take care of our needs. ["Synthetic Liquid Fuels—When and How?" by Eugene Ayres, Jan. '52 PETROLEUM PROCESSING, p. 41.] In the last 20 years we have seen such changes come smoothly with the expanding of chemicals from petroleum.

In the meantime, new petroleum reserves continue to be found, while the old ones are only slowly exhausted. Plenty of oil can be set free for military purposes by a certain amount of substitution by coal and gas.

In addition to oil shale, which Mr. Ayres mentions as a source of a certain amount of medium cost liquid fuel, the Canadian tar sands should be mentioned as a source of an even greater potential added volume of medium cost fuel. Both can be expected to be much less of a drain on the national economy than the large scale manufacture of synthetic liquid fuel from coal by the costly methods now envisioned, such as coal hydrogenation.

K. S. ADAMS
Chairman
Phillips Petroleum Co.
Bartlesville, Okla.

○ My investigations into the oil shale end of the synthetic fuels situation lead me to conclusions parallel to those stated by Mr. Ayres. I may tend to be a bit more optimistic in regard to the present profitability of an oil shale industry, in the expectancy of future technologic improvements, and in the reserves available from oil shale than Mr. Ayres is. Yet, because Mr. Ayres is conservative in regard to oil shale, his predictions regarding future petroleum production in the U. S. assume increased importance and deserve considerable attention.

The study ... shows that the oil industry will not be able to retire to a stodgy old age, but will have to become even more nimble in the future than it has been in the past.

PROF. TELL ERTL
Chairman
Dept. of Mining and Petroleum Engineering
The Ohio State University
Columbus, Ohio

○ I have read Eugene Ayres' article with a great deal of interest and, as usual, believe "Gene" has done an excellent job of stating the "possibilities" and "probabilities" in the synthetic fuel picture. He states that it will require a lot of researching and long-range planning, and that is exactly what we are trying to do at Pitt-Consol. We hope we'll be ready

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Letters

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JOSEPH PUSSGLOVE, JR.
Vice President, Research and Development
Pittsburgh Consolidation Coal Co.
Pittsburgh, Pa.

Graphitization

I wish to offer several comments for publication regarding the article "Protecting Refinery Pressure Equipment from Graphitization" by D. B. Rossheim, J. J. Murphy, R. H. Caughey and W. B. Hoyt. [Dec. 1951 PETROLEUM PROCESSING, pp. 1385-88.]

The authors propose that carbon steel pipe and tubing for temperatures above 850° F. be made in accordance with a deoxidation practice restricted to the maximum use of 0.5 lbs. per ton of aluminum. Further, the material should have a coarse grain size and be free of abnormality in the McQuaid-Ehn carburizing test.

The producers of this material would have considerable difficulty in meeting these requirements. Usually carbon steel seamless pipe and tubing are made with greater quantities of aluminum and very little experience is available concerning the normality of this type of steel.

It is important to have a properly killed steel for the manufacture of carbon steel seamless products by the Mannesmann process, and if graphitization is a problem chromium in conjunction with molybdenum should be employed. The use of molybdenum not only increases the creep strength but also reduces the tendency for embrittlement at elevated temperatures. Chromium will inhibit the formation of graphite.

In plate steels there has been very limited evidence that coarse-grained material free of abnormality in the carburizing test is less susceptible to graphitization. Due to the instability of iron carbide at elevated temperatures the possibilities of graphitization always exist in plain carbon steels. This position is supported by the experimental work reported in a paper published several years ago ("Graphitization of Steel at Elevated Temperatures" by A. B. Wilder and J. D. Tyson, *Trans. Am. Soc. Metals*, Vol. 40, 1948, p. 233). In several carbon steels with no aluminum used for deoxidation, graphitization occurred in relatively short periods of time.

Before further consideration is given to a change in specifications for the manufacture of carbon steel pipe is would also be desirable to evaluate the API Committee results on the extent of graphitization in oil refinery service.

A. B. WILDER
Chief Metallurgist
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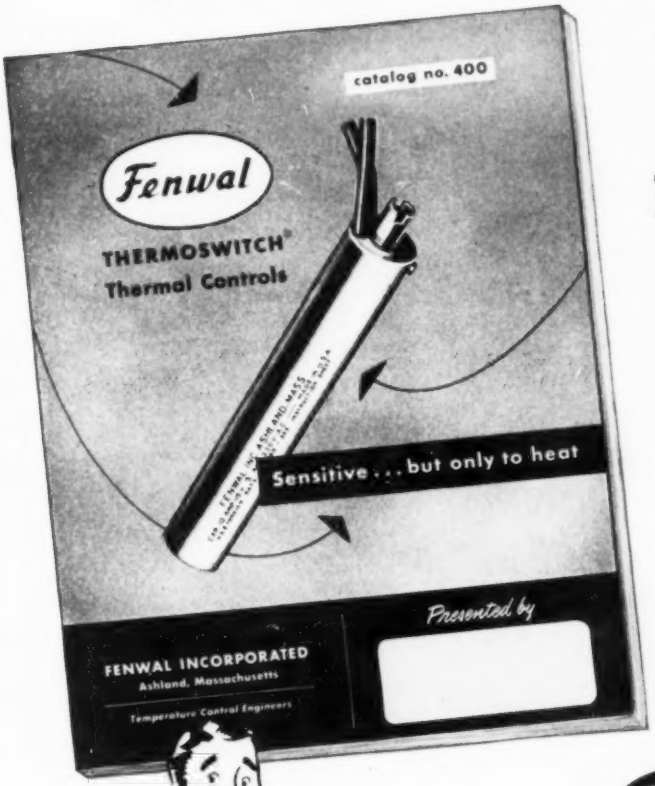

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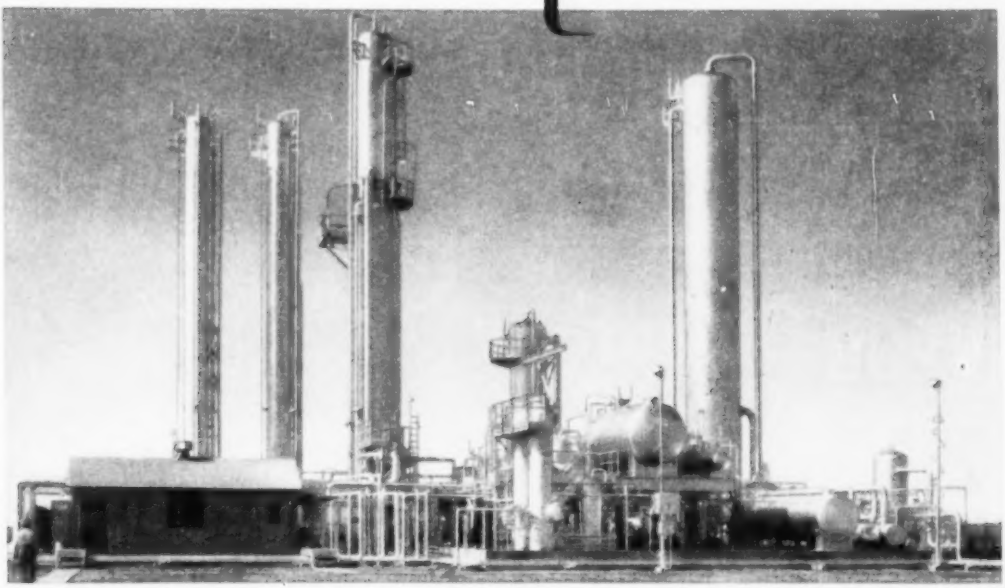

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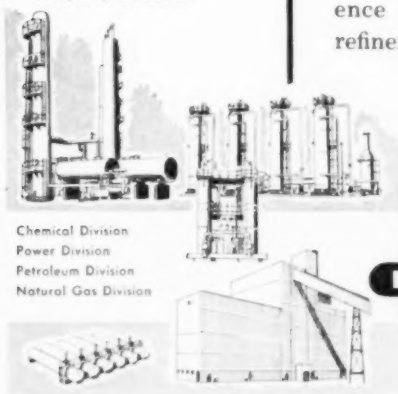

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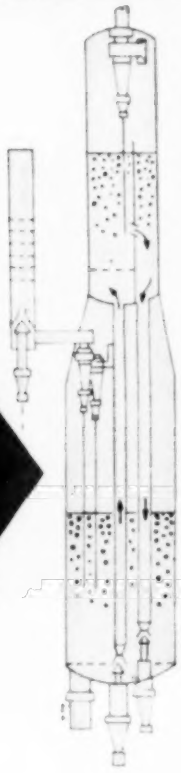

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Superior efficiency and economics are expected of any Fluid catalytic cracking operation—but these units have an additional edge in this respect because built into them is Kellogg's entire experience, culled from engineering more than 50 Fluid units in a period of ten years . . . more than 70% of the world's total Fluid cracking capacity.

Low initial cost is also to be expected of this new Orthoflow design. *One* vessel containing both reactor and regenerator. Less steel work. Smaller foundations. Shorter and fewer catalyst carrier lines. No slide valves. Elimination of expansion joints in the catalyst transportation system.

Such features are bound to reflect favorably on investment costs. But in addition, these Kellogg engineering advances offer decreased maintenance cost because of straight line transmission of catalyst-oil mixtures and spent catalyst. Only the Orthoflow has this erosion-reducing feature. Only the Orthoflow has eliminated the maintenance problem of expansion joints, utilizing specially-designed spring-loaded valves to absorb thermal expansion.

If you are considering the addition of Fluid catalytic cracking to your processing sequence or an increase in your present cracking capacity, you should explore the advantages of the new Kellogg Orthoflow converter.

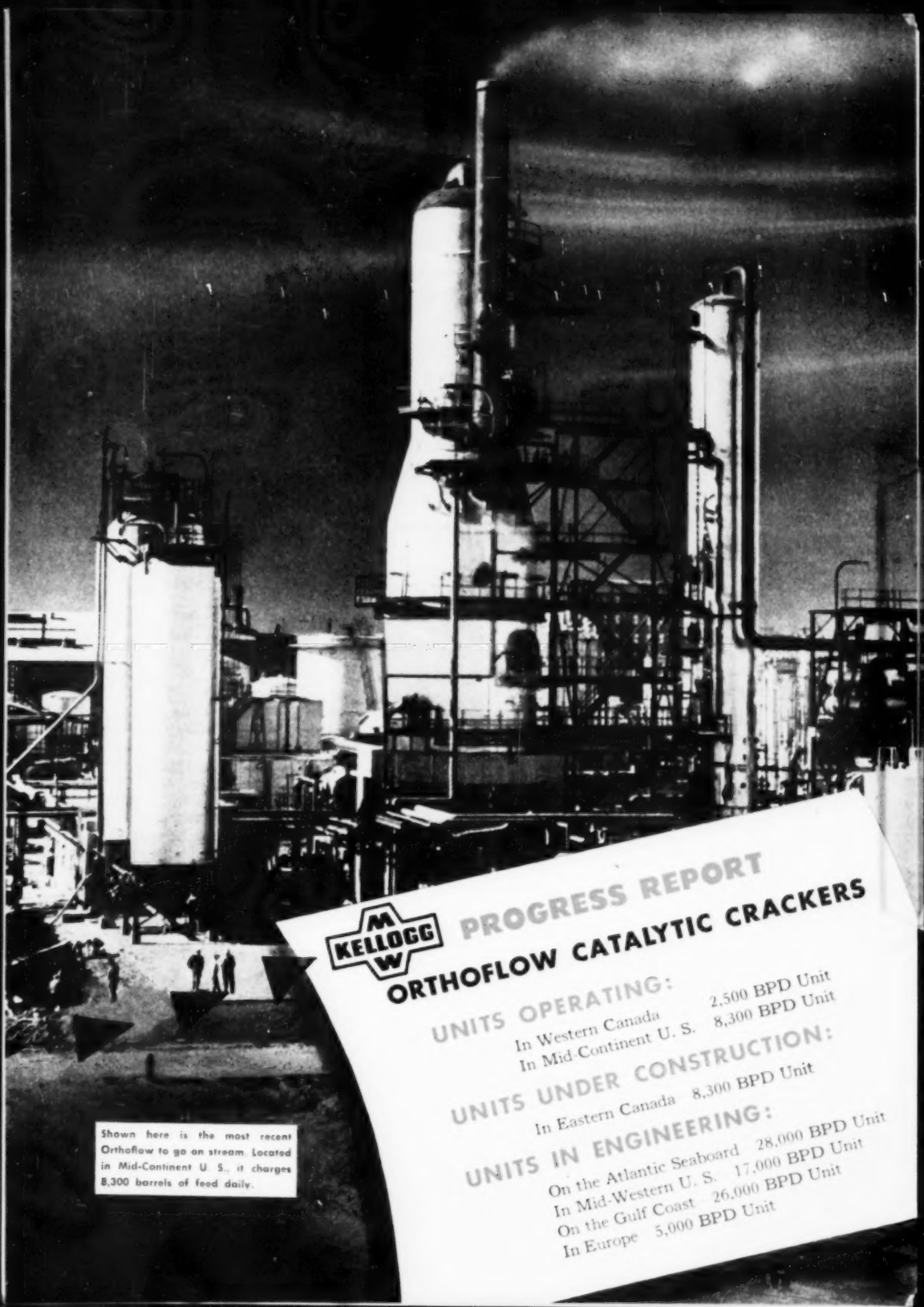
THE M. W. KELLOGG COMPANY

(A Subsidiary of Pullman Incorporated)

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

KELLOGG

for fifty one years an integral part of petroleum refining progress!



Shown here is the most recent Orthoflow to go on stream. Located in Mid-Continent U. S., it charges 8,300 barrels of feed daily.

M W KELLOGG

PROGRESS REPORT

ORTHOFLOW CATALYTIC CRACKERS

UNITS OPERATING:

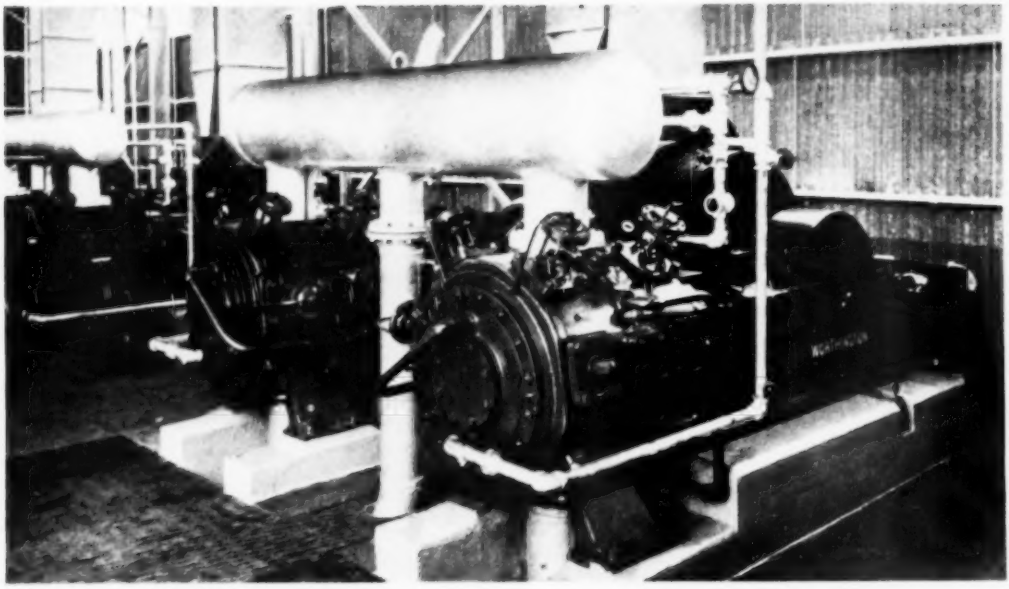
In Western Canada 2,500 BPD Unit
In Mid-Continent U. S. 8,300 BPD Unit

UNITS UNDER CONSTRUCTION:

In Eastern Canada 8,300 BPD Unit

UNITS IN ENGINEERING:

On the Atlantic Seaboard 28,000 BPD Unit
In Mid-Western U. S. 17,000 BPD Unit
On the Gulf Coast 26,000 BPD Unit
In Europe 5,000 BPD Unit



A New Cracking System at Socony-Vacuum
...BUT THE SAME COMPRESSORS

When Socony-Vacuum needed to modernize its catalytic cracking plant in Buffalo, it put in the thermofor process.

To compress hydrocarbons for the process, Socony-Vacuum selected Worthington DC compressors. Why?

Because—the three Worthington compressors on the old Houdry system performed successfully . . . since 1939.

So . . . in addition to these three, Socony-Vacuum now has four more compressors working on the Thermofor unit. One of these four (not shown in the picture) is a 4-cylinder tandem compressor with a unique control system permitting it to operate on either low or high pressure service.

This case illustrates not only the *dependability* of Worthington compressors but also the *adaptability* of the Worthington line to all refinery requirements —all types of gases, all pressures, all capacities. In addition, Worthington provides the broadest line of pumps, engines, refrigeration equipment and other petroleum processing machinery.

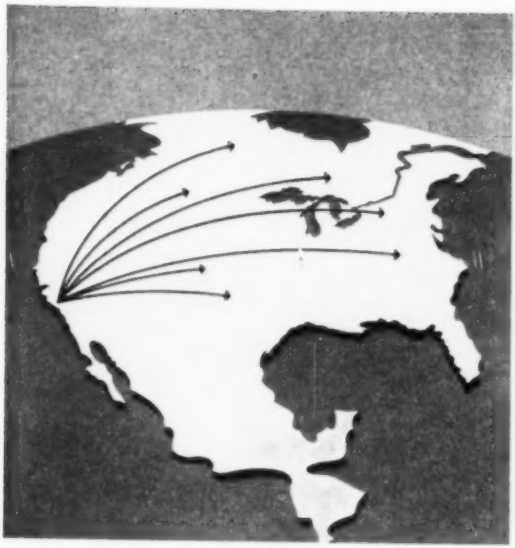
Investigate *more worth in Worthington*. Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, New York.

WORTHINGTON

COMPRESSORS

24K1.4

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



First Aid for Cat Crackers Anywhere

IF YOUR CAT CRACKER DEVELOPS ILLS OR YOU HAVE A TECHNICAL PROBLEM ON CATALYSTS, A FILTROL ENGINEER IS READY TO SERVE YOU ON SHORT NOTICE. IN A RECENT 30-DAY PERIOD OUR ENGINEERS GAVE TECHNICAL FIELD ASSISTANCE AND PERFORMED LABORATORY EVALUATIONS FOR REFINERS OVER A WIDESPREAD AREA THAT INCLUDED EDMONTON, ALBERTA; MONTREAL, QUEBEC; TULSA, HOUSTON, PHILADELPHIA AND LOS ANGELES.

YEARS OF EXPERIENCE IN PRODUCING CRACKING CATALYSTS AND OBSERVANCE OF VARIED CRACKING OPERATIONS FORM A BACKGROUND FOR FILTROL'S TECHNICAL SERVICE AND ASSISTANCE IN THIS FIELD. WRITE FOR PARTICULARS.

OTHER
REASONS FOR USING
FILTROL CATALYSTS

1. HIGHER OCTANE BARRELS
2. HIGH BUTYLENE YIELD
3. LOW COST
4. SULPHUR RESISTANT CATALYSTS
5. FASTER REGENERATION RATE
6. VARIED PLANT FACILITIES
7. UNIFORMITY
8. LOWERED EXCESS BUTANE
9. LOW ATTRITION RATE

FILTROL CORPORATION

OFFICES: 727 WEST SEVENTH ST., LOS ANGELES 17, CALIFORNIA
PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

Filtrol* CATALYSTS AND ADSORBENTS

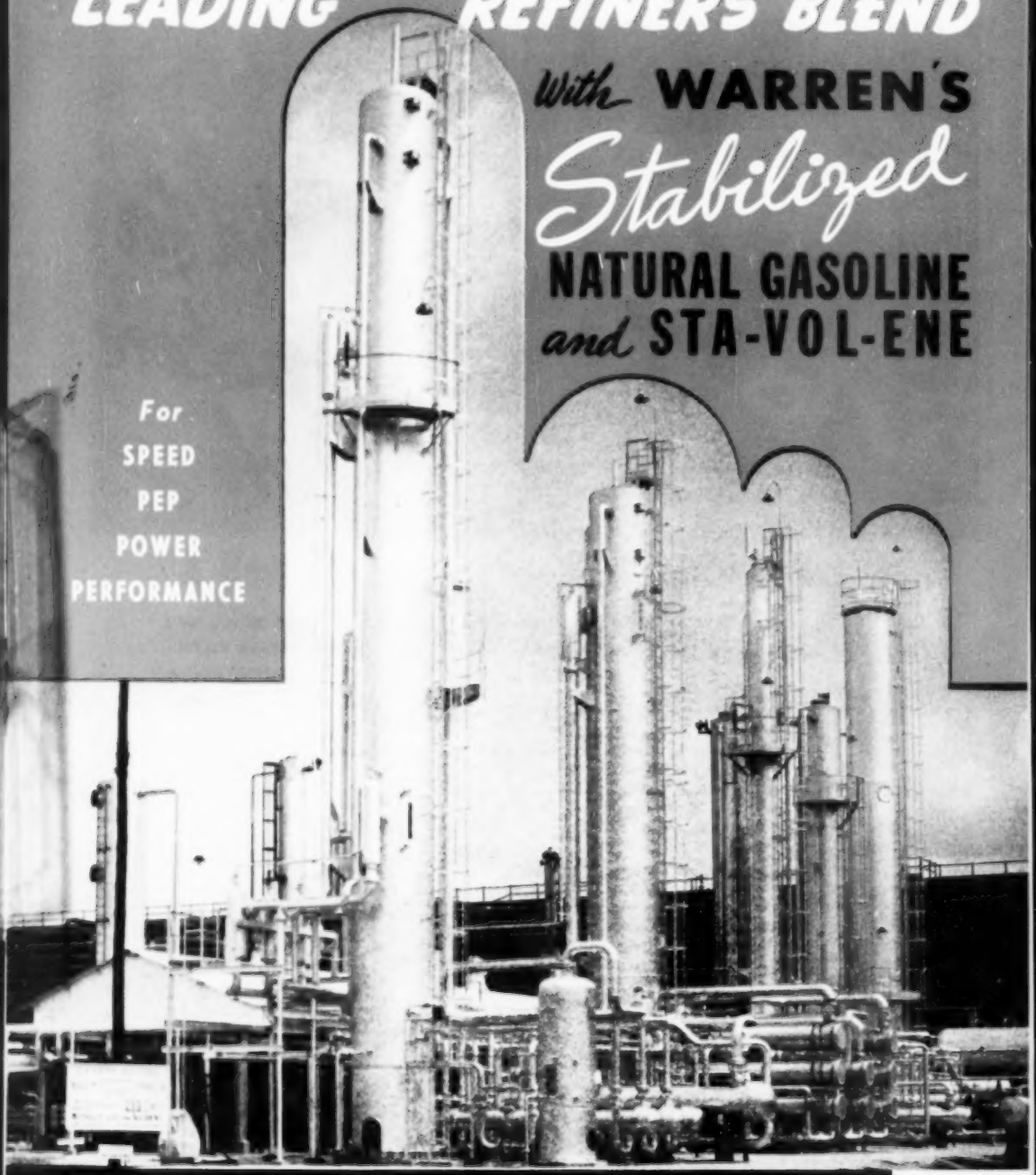
* T.M. REG. U.S. PAT. OFF.

(To obtain more data on advertised products see page 248)

LEADING REFINERS BLEND

With WARREN'S Stabilized NATURAL GASOLINE and STA-VOL-ENE

For
SPEED
PEP
POWER
PERFORMANCE



WARREN PETROLEUM CORPORATION

Producers, Manufacturers, Exporters and Marketers

Export Terminals: Corpus Christi, Port Arthur, Baytown, Texas City, and Norsworthy, Houston, Texas.

TULSA 2, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren

30 YEARS SERVIC

Crude Oil, Natural Gasoline and Liquefied Petroleum Products

This is important enough to read twice!

If you are an engineer plagued by scale, corrosion, pitting and tuberculation in your cooling water system, then here's positive help!

Now for the *first time* you can be sure of complete protection from these common enemies of your cooling water system through the use of the Betz Dianodic Method.

In this advanced method, the combination of two anodic inhibitors under proper conditions of concentration and pH eliminate pitting and tuberculation which present day methods are unable to control even at much higher concentrations. The Dianodic Method effectively rids your system of pitting and tuberculation, and at the same time provides even greater protection against general corrosion.

In actual field operation, results are outstanding. Take, for example, the case of a large plant who operates with a 250 gpm circulation rate and a 15° F. temperature drop through the tower. Prior to the application of the Dianodic Method, the complete tube bundle was replaced due to corrosion after 18 months' operation.

With the use of this advanced Betz technique over a period of 11 months, test specimens and inspection of the system showed freedom from corrosion or pitting.

This is just one case among many where the Betz Dianodic Method is providing the means for more efficient plant operation. Why not ask a Betz Engineer how the Dianodic Method can help you? Ask him too, about Betz *Specialized* Water Conditioning Service for all other water problems. You'll save yourself time, money and a lot of trouble. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: Betz Laboratories Limited, Montreal 1.

For complete information on the Dianodic Method, write today for Betz Technical Paper No. 123.

BETZ

CONSULTANTS ON ALL WATER PROBLEMS

DEPENDABILITY IN CATALYSTS CANNOT BE SEEN

Top uniformity and dependability are available to you in Davison's microspheroidal (M-S*) or ground (DA-1*) synthetic fluid-type cracking catalysts. The accompanying photomicrographs show the physical characteristics of the DA-1 and new M-S catalysts produced in Davison's Cincinnati plant. Uniform physical and catalytic characteristics result from Davison's modern facilities and years of technical experience and research. Experienced Davison Field Service Engineers—complete laboratory facilities—are all part of Davison Dependability—Dependability with the big "D".

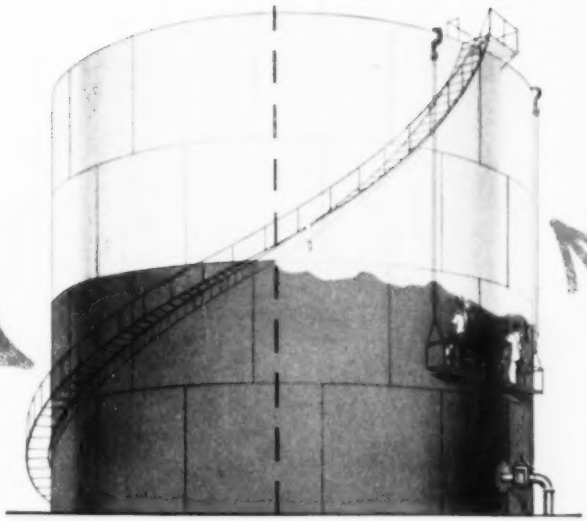
*T.M.T.D.C.C.

Progress Through Chemistry

THE DAVISON CHEMICAL CORPORATION

Baltimore 3, Maryland

PRODUCERS OF CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS



a good

START...

a better

FINISH!

4-way protection with SHERWIN-WILLIAMS KROMIK® PRIMER

- **PENETRATES** into joints and rivet holes
- **PREVENTS** rust and corrosion
- **PROTECTS** against abrasion with tough, elastic film
- **WITHSTANDS** sun and weather, even without top coat

Tough, long-lasting KEM® SYNTHETIC TANK PAINT

- **SELF-CLEANING**—stays brilliant white
- **HIGHLY REFLECTIVE**—reduces evaporation losses
- **FUME-RESISTING**—gives longer service

Start the job *right*—with the heavy-duty, *multiple-pigment* primer proved in more than 25 years of industry-wide service—Sherwin-Williams KROMIK Primer. KROMIK includes not only the best protective properties of red lead, but also those of three other protective pigments as well.

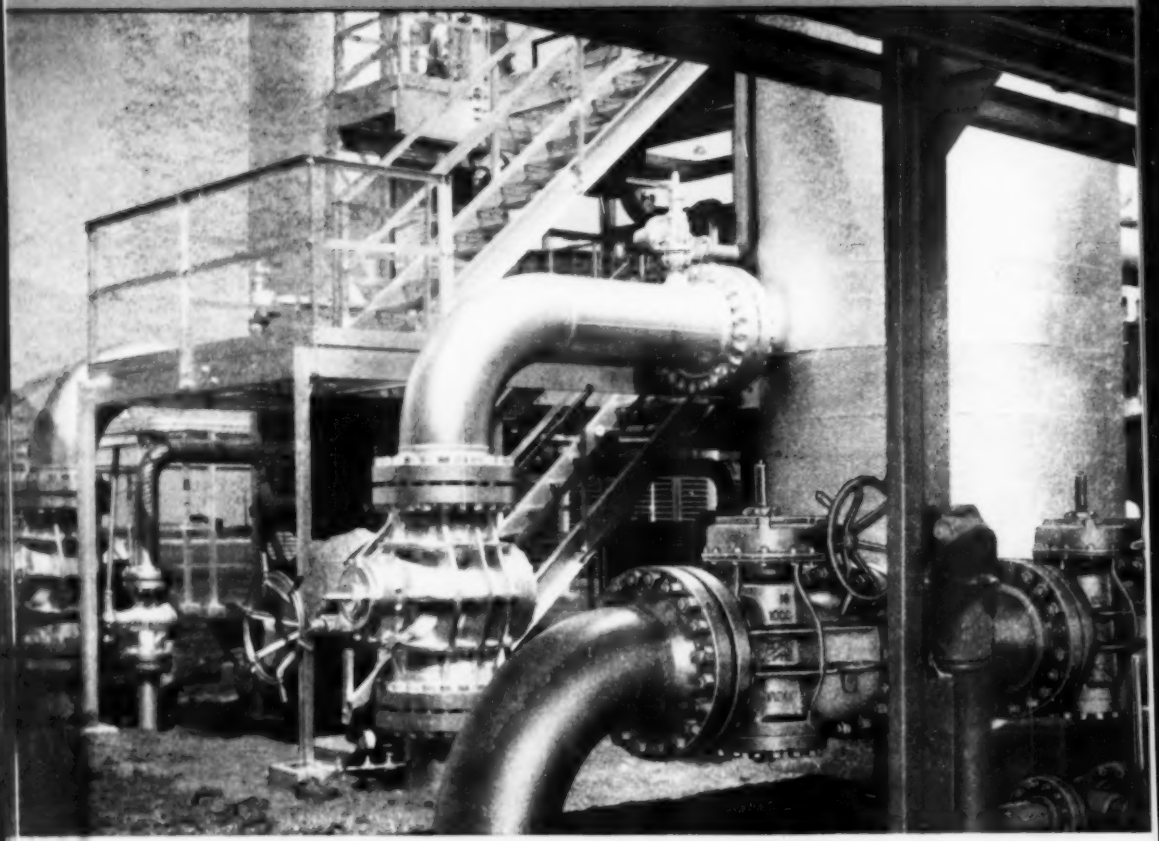
Finish the job *better*, because KROMIK provides the soundest possible foundation for long-lasting, brilliantly clean Sherwin-Williams Kem Tank White Finishes. Especially designed for petroleum service, their fume-resisting high reflectivity keeps temperatures lower within the tanks . . . reduces costly evaporation of high volatiles. Ask your Sherwin-Williams representative today for data on these or other of the complete line of Sherwin-Williams Petroleum Industry Finishes—or write The Sherwin-Williams Co., Transportation Division, Cleveland 1, Ohio.

SHERWIN-WILLIAMS

PETROLEUM FINISHES

(To obtain more data on advertised products see page 218)

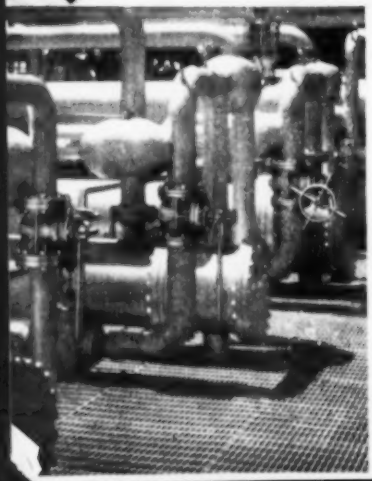
IT'S EASY TO FIT THE RIGHT

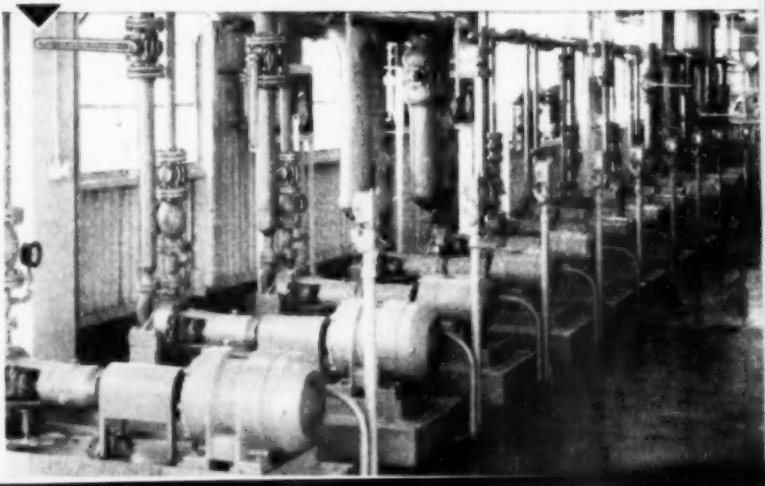


SPECIAL APPLICATIONS Nordstrom experience can tell you what special refinery applications you can successfully make with Nordstrom valves.

INSIDE OR OUT The same characteristics that make Nordstroms the most economical valves for unusual line conditions make them the best bet on inside equipment lines.

ALL SIZES There's a Nordstrom valve in the right size, the right pressure class, the right metals, the right end connection, and the right lubricant for nearly every refinery or gasoline plant service.





NORDSTROM VALVE TO *Gasoline Plant and Refinery Services*

With the background of several hundred thousand Nordstrom valves in refinery service around the world, Nordstrom engineers can help you select the best, most efficient designs for each type of refinery operation.

Nordstrom valves are especially suitable for refinery lines. The extra seal of plastic lubricant around the seat port area protects seating surfaces against line fluid, and at the same time gives a hydraulic jacking action for easy opening where line conditions cause many valves to stick.

For nearly all complex, hard-to-control refinery line fluids there are suitable Nordstrom valves. These are typical Nordstrom services:

HANDLING HYDROCARBONS—Loading rack, marine terminals, general transfer and run-down lines and other applications throughout the refinery where light hydrocarbons are the line fluid.

CHEMICAL TREATING—Handling treating acids, caustic, Doctor Solution, copper chloride and other reagents, in continuous or batching processes. Special metals are available.

LUBE OIL TREATING—Selective solvent treating of lube oils, including treatment with phenol, etc., along with the deasphalting of oils with propane, methyl ethyl ketone and other methods.

REFINERY GASES—In unit operations or compressor plants, Nordstrom lubricant-sealed valves are generally preferred.

AVIATION GASOLINE PRODUCTION—Manufacture of alkylate for making high octane gasoline, either by the sulphuric acid process or anhydrous hydrofluoric acid process. Special metals, packings and flow area facings are available.

WATER SERVICES—Condenser service, water process lines and power plant lines.

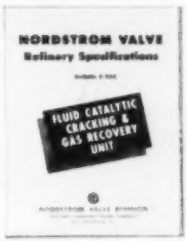
AIR LINES—All types of air service lines.

PETRO-CHEMICAL MANUFACTURE—Examples: phthalic anhydride, isopropyl alcohol, synthetic glycerine, synthetic ethyl alcohol, napthenic acids and other petroleum based chemicals.

Now You Can Easily Fit Nordstrom Valves to the Specific Services in Your Specific Refining Process

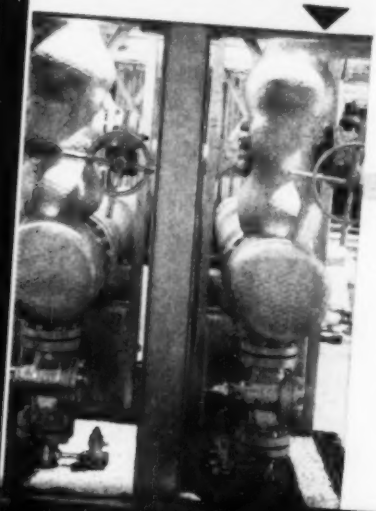
So that refinery engineers can select the proper Nordstrom Valves for each service in the principal refining processes, a series of specification sheets showing recommended materials, pressure classes, lubricants and valve figure numbers has been prepared. There is a special Nordstrom Specification Bulletin for each of these processes:

Catalytic Polymerization	Fluid Catalytic Cracking and Gas Recovery	Phenol Extraction
Crude Topping and Vacuum Distillation	Girbotol Process	Propane Deasphalting
Cycleversion	Houdriflow Catalytic Cracking and Gas Recovery	Propane Dewaxing
Delayed Coking	Hydroforming Process	Solexol Process
Distillate Recovery in Cycling Plants	Light Ends Fractionation	Solvent Dewaxing
Duo-Sol Solvent Extraction	Naphtha Polyforming	Thermal Cracking
		Thermal Reforming



A Nordstrom service engineer will be glad to review these specification sheets with you. Call your nearest Rockwell office or write to Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

EASY STANDARDIZATION Because Nordstrom builds such a wide range of types and sizes, with wrench, geared or automatic operation, you can standardize on them throughout the refinery or gasoline plant.



There's an oil field supply store with Nordstrom Valves and Nordstrom Service as close as your telephone.

Rockwell Built

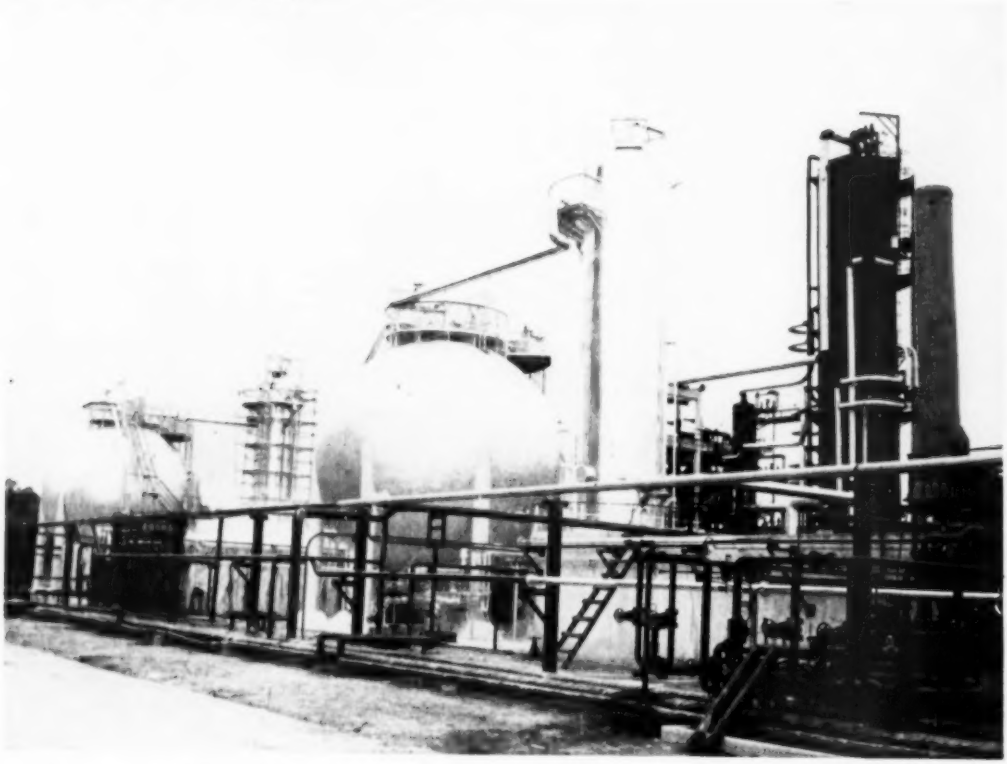
Another ROCKWELL Product

Nordstrom Valves

Lubricant Sealed to Keep Upkeep Down

ROCKWELL MANUFACTURING COMPANY
400 N. Lexington Ave., Pittsburgh 8, Pa.

CITIES SERVICE } another leading refiner desalts with PETRECO



Cities Service has long been recognized for progressive leadership, dependable excellence of product and refining know-how. The first Petreco Desalter for Cities Service was installed in their East Chicago, Indiana, refinery. When their great new refinery at Lake Charles, Louisiana, was built, Petreco Desalters were installed as part of the regular refining flow system.

There is only one way to earn a *repeat* installation for a company such as Cities Service, and that is to produce results the first time. In this particular case the Petreco Electrosphere to the right in the picture above has delivered throughputs as high as 75,000 barrels per day for extended periods of time and was a considerable factor in the topping units continuous fifteen months run during which 30,000,000 barrels of oil were processed. Results such as these are the reasons why leading refiners continue to specify Petreco Desalting and Petreco Service.

PETRECO PROVIDES COMPLETE DESALTING SERVICE AND FACILITIES

PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES | DESALTING DEHYDRATING

Petrolite Corporation, Ltd.
PETRECO DIVISION
3202 South Wayside Drive, Houston 3, Texas
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It's comprehensive—completely revised and expanded

It was written especially for use by engineers responsible for the selection of materials in the power plant, oil refining, chemical processing and marine fields.

for efficient heat transfer

ANACONDA®

HEAT EXCHANGER TUBES

The American Brass Company, Waterbury 20, Conn.

Please send me the new edition of Publication B-2, "ANACONDA Tubes and Plates for Condensers and Heat Exchangers."

NAME.....

COMPANY.....

STREET.....

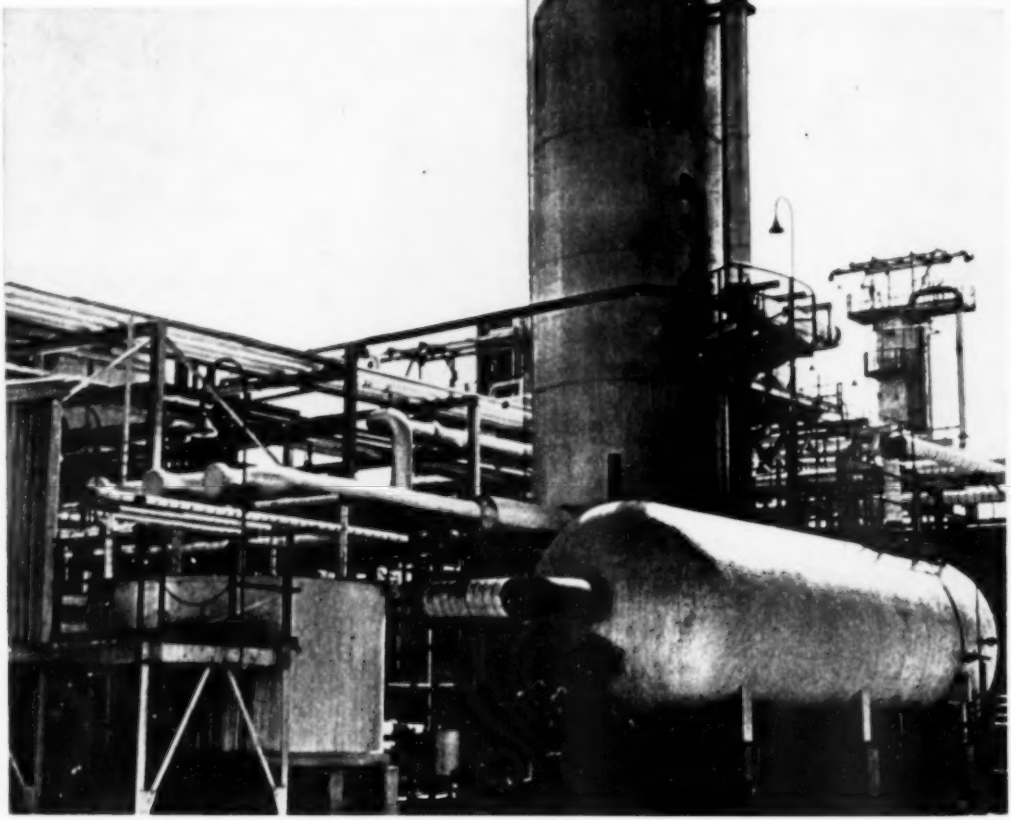
CITY.....ZONE.....STATE.....

TRETOLITE

assures these money-saving advantages

- Low installation costs
- Low operating costs
- Effective salt removal
- Periodic servicing
- Continuing research

CHEMICAL DESALTING



HIGH EFFICIENCY

LOW COST

In many of America's leading refineries Tretolite desalting is delivering salt removals as high as 90 to 95%. The low water requirement seldom exceeds 5 to 8% of the total volume of the crude charge. Tretolite desalters now in use range in capacity from 2,000 to 50,000 barrels per day per plant, since Tretolite desalting is adaptable to either large or small refining operations. Periodic checking by Tretolite desalting engineers insures that your Tretolite desalting process stays at top operating efficiency.

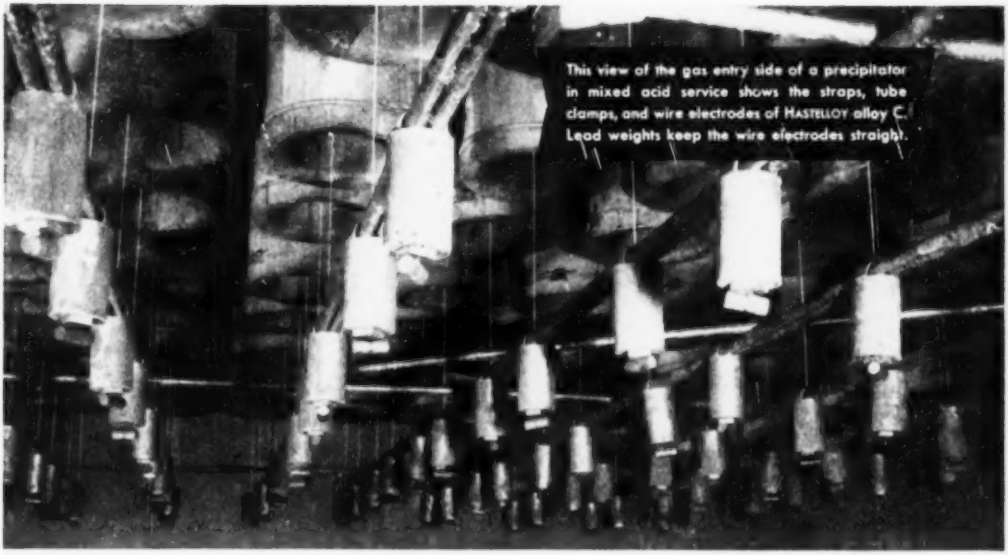
The recognized economy of Tretolite desalting is due to the high flexibility of the process. This process flexibility often permits the use of existing refinery equipment as part of the desalting installation, obviously holding installation costs at a minimum. This low installation cost, plus the low water, heat and chemical requirements, helps to hold Tretolite desalting cost per barrel at a minimum.

TRETOLITE COMPANY *Chemicals for the Petroleum Industry*

ST. LOUIS 19, MISSOURI • LOS ANGELES 22, CALIFORNIA

DESALTING • DEHYDRATING • WATER DEOILING • CORROSION INHIBITION • SCALE PREVENTION

TD 51-1



This view of the gas entry side of a precipitator in mixed acid service shows the straps, tube clamps, and wire electrodes of HASTELLOY alloy C. Lead weights keep the wire electrodes straight.

Precipitators Improved...

WITH NICKEL-ALLOY ELECTRODES

Electrostatic precipitators for removing corrosive liquids and solid particles from industrial process gases give better and longer service, without maintenance, when HASTELLOY alloy wire is used for electrodes. The alloy has excellent mechanical strength (130,000 psi) and is not attacked by the corrosive agents. This combination of properties makes it possible to use electrodes that are only 0.073 in. in diameter. The effective diameter of the lead-covered wire formerly used in most units was more than 0.500 inch. The smaller cross-section of the HASTELLOY alloy wire permits the use of higher voltages with a more uniform corona pattern.

HASTELLOY alloy C electrodes have been installed in mist precipitators where hydrochloric, sulphuric, sulphurous, and mixed acids were present. A recent check on an installation in an acid plant showed that the alloy C wires experienced no weight loss after a year's operation. Lead-covered steel wires, on the other hand, lasted an average of 11 months with electrode failure at least once a week.

For information on wrought forms of HASTELLOY alloy, write for the booklet, "HAYNES Wrought Alloys Price List."

HAYNES alloys
TRADE-MARK

"Haynes" and "Hastelloy" are trade marks of Union Carbide and Carbon Corporation

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
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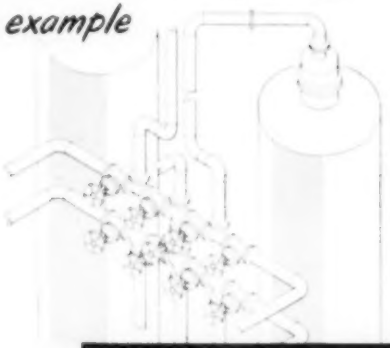
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

Are You Getting Valve Satisfaction?

Like this Refinery

for example



THE INSTALLATION

Nine Crane valves on control manifold to reaction chambers on Perco Cycloversion Unit. Barcco Oil Company, Wichita, Kansas.

THE HISTORY

Valves formerly used would not stay absolutely tight as necessary. Down time for repairs was excessive. Fluids handled: At oil inlet, straight run gasoline at 950 Deg. F., 85 psi; for catalyst regeneration, air-steam mixture at 850 Deg. F., 15 psi; regeneration waste gases, 1200 Deg. F. at 5 psi. Approximately 15-day cyclic operation.

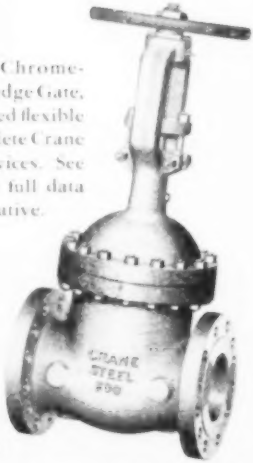
Replacement made with Crane Valves. After more than 2 years' service, with no maintenance required, all Crane Valves are absolutely tight and operating at highest efficiency.

VALVE SERVICE RATINGS

SUITABILITY:	Matches service needs
MAINTENANCE COST:	None to date
CORROSION-RESISTANCE:	O.K.
SERVICE LIFE:	Now more than 2 yrs.
OPERATING RESULTS:	Valve leakage stopped
PRICE:	In line
AVAILABILITY:	Local Crane Suppliers

THE VALVE

Crane 900-Pound No. 5 Chrome-Molybdenum Alloy Steel Wedge Gate, with Stellite seats and patented flexible disc design. One of the complete Crane steel family for refinery services. See your Crane Catalog or get full data from your Crane Representative.



The Complete Crane Line Meets All Valve Needs. That's Why,

More Crane Valves Are Used Than Any Other Make!

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

30% extra thruput GUARANTEED

UP TO 50% EXTRA THRUPUT *OBTAINED* BY USING KOCH KASKADE FRACTIONATING TRAYS

LEONARD REFINING CO.
ALMA, MICHIGAN

Obtained increased thruput on 72" I.D., TCC synthetic crude tower to capacities of:

	Liquid	Vapor
Volume	115,300 ≡/hr.	82,480 ≡/hr.
Density	45.1 ≡/cf	175 ≡/cf
Δp tray		1.38" H_2O

Koch Kaskade trays were installed on present supports — 36" centers.

PHILLIPS PETROLEUM CO.
WOODS CROSS, UTAH, REFINERY

Obtained increased thruput on 30" diameter, 110≡ psig. poly stabilizer to capacities of:

	Liquid	Vapor
Volume	36,700 ≡/hr.	29,000 ≡/hr.
Density ≡ Cf	29.6	1.317

Koch Kaskade trays were installed on 24" centers.

WARREN PETROLEUM CO.
RINGWOOD, OKLA., GASOLINE PLANT

Obtained increased capacity on 72" 750≡ natural gas absorber to:

	Liquid	Vapor
Volume	460 gpm (lean)	75 mm CF D
Density ≡ CF	38° API (lean)	2.43 ≡ CF

Koch Kaskade trays were installed on 26" centers.

When extra thruput is your problem, it will pay you to investigate the economy and operating efficiency of Koch Kaskade Fractionating Trays. Write us today — no obligation.

KOCH ENGINEERING COMPANY, INC.

DESIGNERS · MANUFACTURERS · BUILDERS
221 WEST DOUGLAS — WICHITA 2, KANSAS

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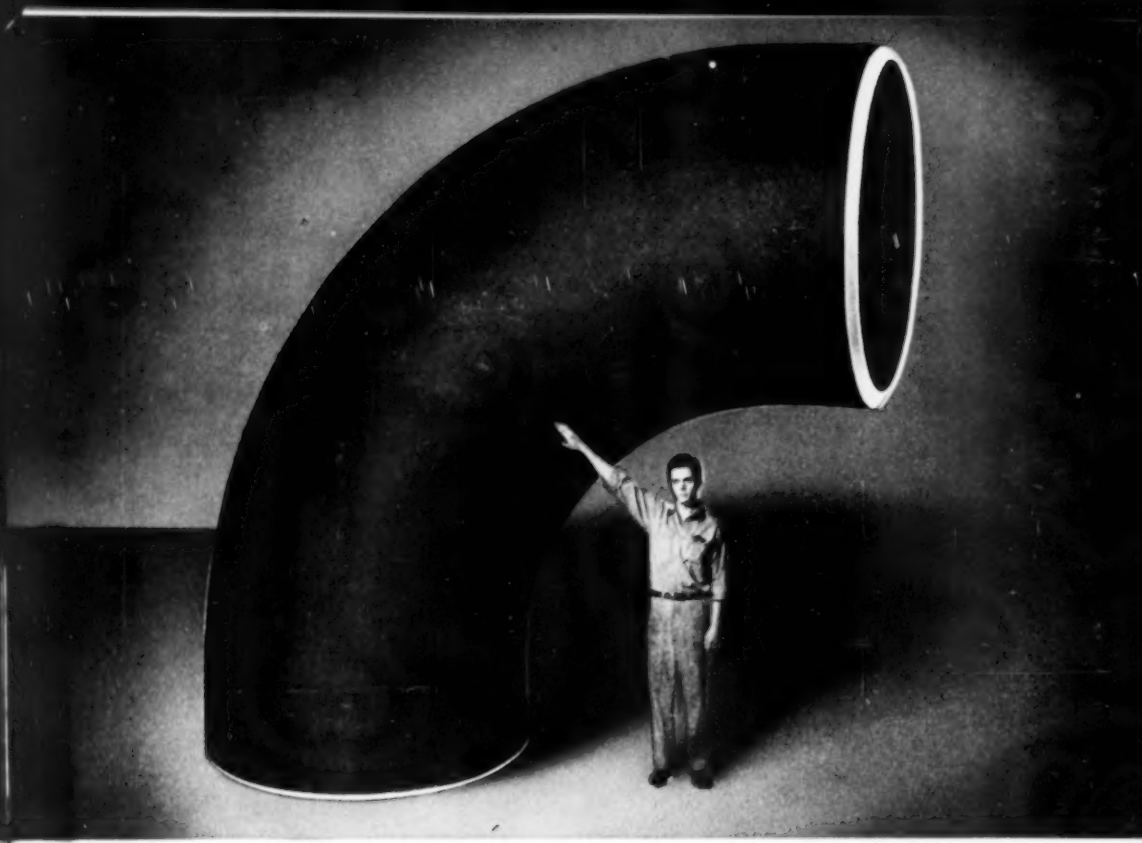
Messrs. A. F. Craig & Co.? Ltd.
Paisley, Scotland



We Haven't Made Them This Big... *YET,*

but this photographic fantasy is simply to remind you that we do manufacture the most varied line of welding elbows on the market.

MIDWEST
PIPING & SUPPLY CO., Inc.

Main Office: 1450 South Second Street, St. Louis 4, Mo.
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Sales Offices: New York 7—30 Church St. • Chicago 3—79 West Monroe St.
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Tulsa 3—224 Wright Bldg. • Boston 27—426 First St.
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

Same radius as ASA but tangent equal to 2½" of nominal pipe size on each end. Saves pipe, layout and welding time. Costs no more than ASA. Sizes to 24".

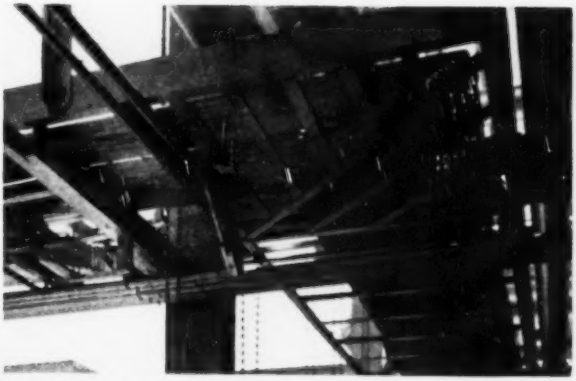
Dimensions conform to applicable size range of American Standard for Butt Welding Fittings, ASA B16.9. Tolerances much less than allowable. Sizes to 26".

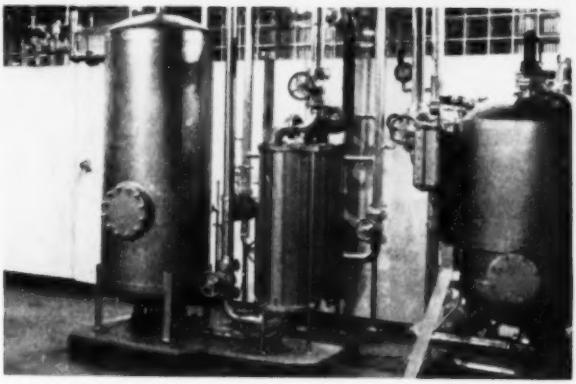
Recommended where space limitations do not permit use of "Long Tangent" or ASA Elbows. Sizes to 30".

Takes the place of a straight size elbow and a reducer. Eliminates one weld; reduces pressure drop, easier to insulate. Sizes to 12", reductions to half size.

Teamed up for

INSTRUMENT ACCURACY:



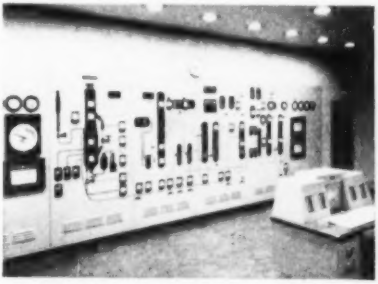


Aluminum Tubing... kept DRY by Lectrodryer

(Upper Photo) Instrument air lines of aluminum tubing at McMurrey Refinery Company's new, ultra-modern plant at Tyler, Texas. *(Lower Photo)* No freeze-ups, no instrument clogging because this Lectrodryer keeps air lines DRY.

Aluminum tubing resists corrosion in sulphur-laden refinery atmospheres. Team up that tubing with a Lectrodryer® to feed air to instruments at −50° F. dew point, and get maximum instrument accuracy. No moisture to cause freeze-ups. No rust, scale or sludge to clog delicate instrument ports.

Lectrodryers do away with WETth (unwanted moisture) in air, gases and organic liquids. They can give you DRY-ness down to three or four parts per million—continuously, automatically, economically. Let us work with you when you have to stop WETth. We've been helping organizations like yours for 20 years. Pittsburgh Lectrodryer Corporation, 332 32nd Street, Pittsburgh 30, Penna.



McMurrey's control room is a model of clean, functional design.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

® REGISTERED TRADEMARK U. S. PAT. OFF.

gives you a winning team

You can count on a winner every time when you use the Bethlehem Continuous-Thread Stud, together with Bethlehem Quenched Nuts, in high-temperature, high-pressure bolting applications. For this assembly is a hard team to beat. It has what it takes to perform economically under difficult bolting conditions.

STUD FIGHTS PREMATURE FAILURE—The Bethlehem Continuous-Thread Stud stands up under continued high temperatures and high pressures because of its ability to minimize stress-concentrations. This stud has no point of thread runout. Therefore it is impossible for stresses to concentrate at any one point to induce premature failure. Instead, stresses are spread over the full working length of the stud.

QUENCHED NUT HAS SUPER STRENGTH—The Bethlehem Quenched Nut is economical because its super strength is forged right into the body of the nut. This nut is different from common nuts because of its method of manufacture and its carbon content. It is forged from a high-quality 30-to-50 carbon steel. After forging, the nut undergoes controlled quenching and tempering, arming it sufficiently to develop the strength of any stud or bolt on which it is used.

The Bethlehem Continuous-Thread Stud and the Bethlehem Quenched Nut are made in a wide size range. They form an economical team for refinery bolting, one which is well worth looking into.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

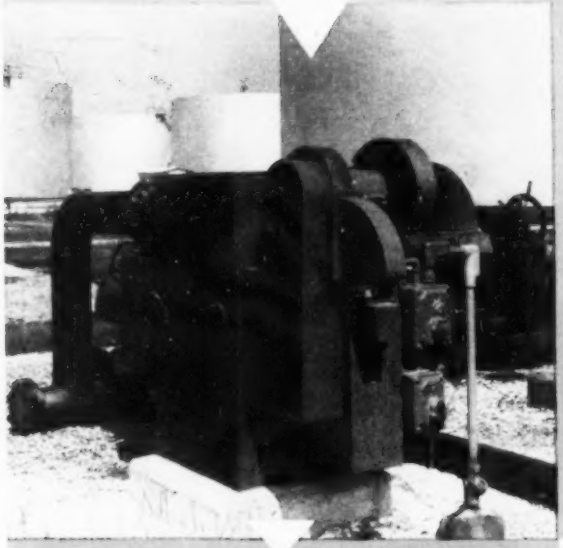
Bethlehem supplies every type of Fastener

(To obtain more data on advertised products see page 248)

Tank farm at the Cit-Con Oil Corporation refinery near Lake Charles, Louisiana. Here, for the first time, air is being dried by ALCOA *Activated* Alumina and passed over the surface of lube oils to prevent the entry of outside moisture which might contaminate the products.

Another first for ALCOA *Activated* Alumina:

Protecting Finished Oils from Water Contamination



Charged with ALCOA *Activated* Alumina, this is one of eight dehumidifiers serving dry air to 17 tanks with a combined capacity of 460,000 bbl. Units were designed to handle 350 SCFM dried to 74° F. dew point at ⅜" water column, with inlet air at atmospheric pressure and 86° F. Quality control tests have found no moisture in the finished oils since the dryers first went into operation in 1949.

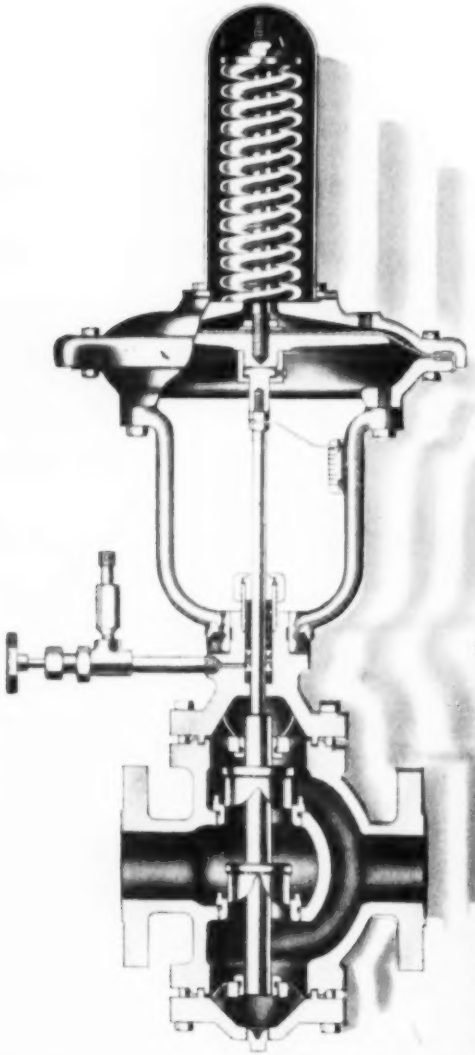
Not only at Cit-Con, but throughout the petroleum industry, ALCOA *Activated* Alumina is improving processes and speeding up production in a number of ways. Commercially pure, it is one of the few solid adsorbents that does not change its form or properties. It will not swell, soften or disintegrate, is non-corrosive and practically iron-free.

Whatever your drying problem, it will pay you to investigate ALCOA *Activated* Alumina. Its versatility and reputation as a dependable, economical drying agent are ready to go to work for you. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 616B Gulf Building, Pittsburgh 19, Pennsylvania.

Alcoa Chemicals

ALCOA ALUMINAS and FLUORIDES

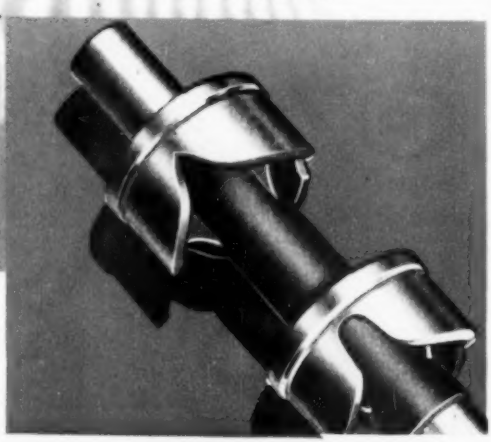
LET 60,000 INSTALLATIONS GUIDE YOU TO BETTER PROPORTIONAL CONTROL



Optimum flow characteristics, coupled with free-floating, self-aligning motor action, have made "Stabilflo" the most preferred name in control valves. Ever since the development of proportional control, critical users have depended upon these wide-range V-port valves for the utmost in performance.

Because of their unique port design, Stabilflo Valves give very precise "equal percentage" flow relations throughout the range from 2 to 100% of flow. Their rangeability is 50-to-1. With these valves, you can be sure that the extraordinary sensitivity, accuracy and dependability of modern proportional controllers are translated into matching valve performance. Get the details in Bulletin 277-2. Write **The Foxboro Company, 2462 Neponset Ave., Foxboro, Mass., U. S. A.**

Here is the Foxboro Exponential Port that gives Stabilflo Valves their unique equal percentage characteristic.

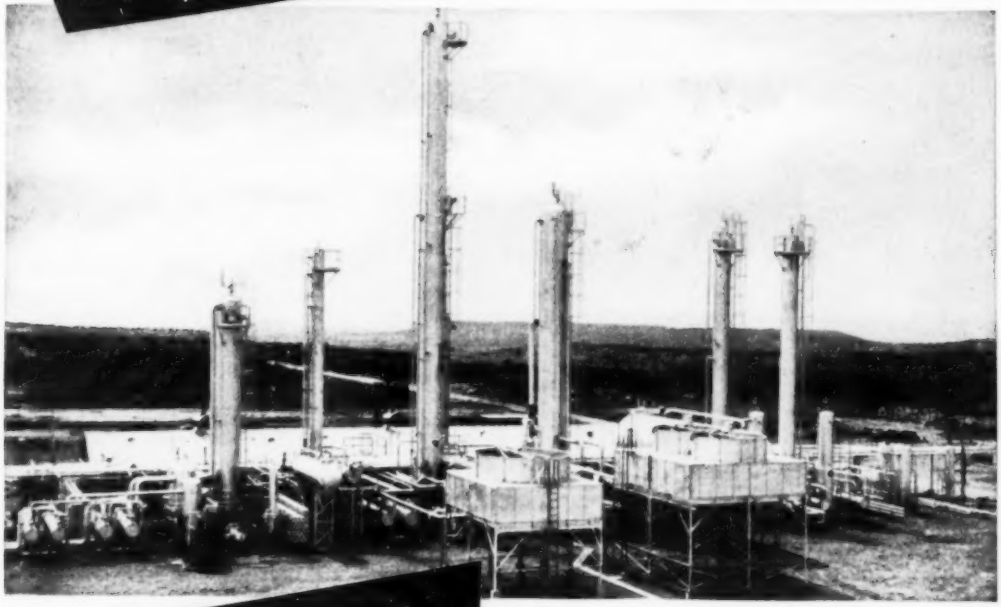


FOXBORO
REG. U. S. PAT. OFF.

STABILFLO CONTROL VALVES

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

Reduce Fouling in your plant



with **BROWN FINTUBE** *sectional hairpin heat exchangers*

● Brown Sectional Heat Exchangers, with their integral one-piece extended surface fintubes, reduce fouling, just a few hundredths of an inch of which on a tube causes a major loss in heat transfer efficiency.

These exchangers assure efficient operation at low "skin" temperatures, minimizing coking and building up on the fintubes. And the controlled flow through the longitudinal passages keeps all the material in continuous motion. There are no baffles, back-eddies or stagnant areas to encourage fouling.

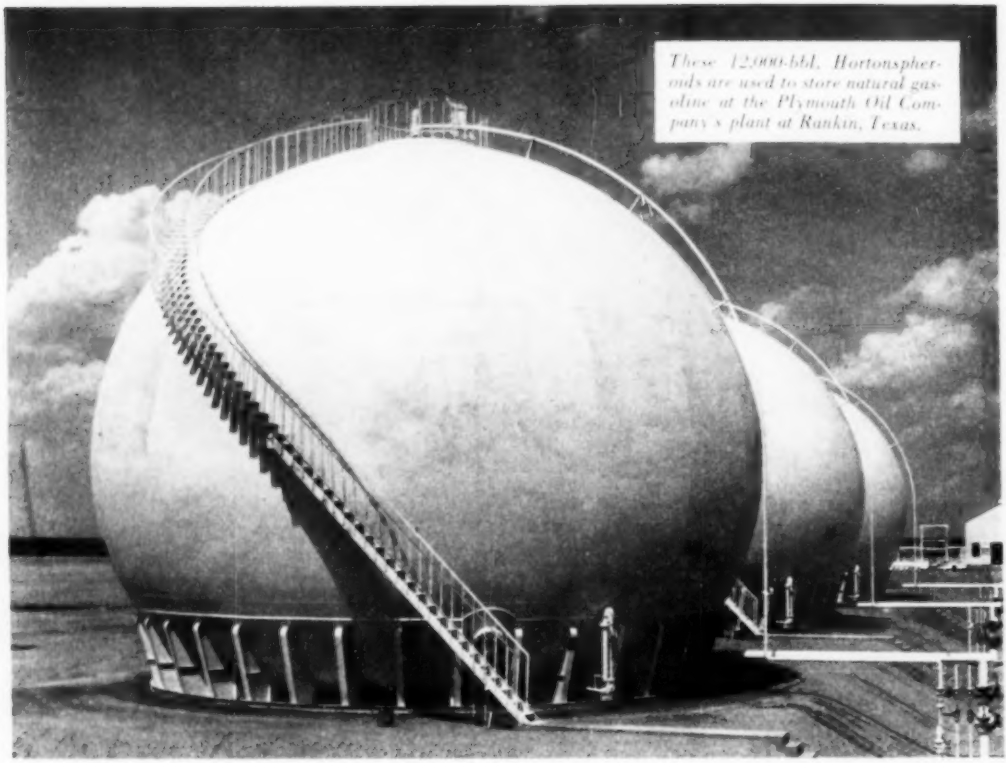
For top operating efficiency and reduced fouling use Brown Sectional Heat Exchangers throughout your plant. ***Write for Bulletin No. 481.***

THE BROWN FINTUBE CO.

Elyria, Ohio

Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integrally Welded Fintubes for Any Heating, Cooling or Heat Transfer Service

NEW YORK • BOSTON • PHILADELPHIA • WILMINGTON • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI • DETROIT • CHICAGO
ST. PAUL • ST. LOUIS • MEMPHIS • BIRMINGHAM • NEW ORLEANS • TULSA • HOUSTON • LOS ANGELES • SAN FRANCISCO



These 12,000-bbl. Hortonspheroids are used to store natural gasoline at the Plymouth Oil Company's plant at Rankin, Texas.

Where and *Why* of storing natural gasoline

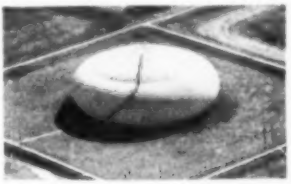
Where (in what type tank) should you store natural gasoline? If you want . . . to protect the volatility and octane rating . . . take advantage of seasonal price variations . . . keep the fire hazard to a minimum—then the Hortonspheroid is the container for you.

Why does the Hortonspheroid give you these benefits? It protects the volatility and octane rating of natural gasoline because it is designed specifically to prevent the excessive evaporation losses that occur when this volatile liquid is stored in conventional tanks. The Hortonspheroid can be designed to withstand the maximum pressure variations caused by daily temperature change, and so does not vent the light fractions under normal operating conditions. These light fractions are important for they give natural gasoline most of its value as an ingredient of blended motor fuel.

Here's how to take advantage of seasonal price variations. Purchase or produce your natural gasoline in the spring. Then store it in the Hortonspheroid until the fall when the demand (and price) is likely to be higher.

Since the Hortonspheroid does not vent under normal conditions, the fire hazard is reduced.

Plain Hortonspheroids (above) are built in standard capacities from 2,000 to 30,000 bbls., while noded Hortonspheroids (right) are built in capacities up to 120,000 bbls. Write our nearest office for Bulletin E for details.



CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY *and* GREENVILLE, PENNSYLVANIA

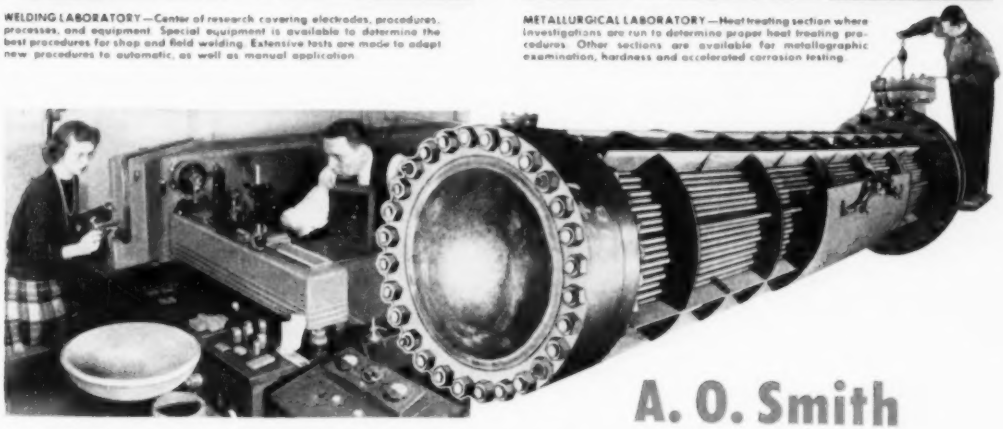
Atlanta 3	2103 Healey Building	Detroit 26	1532 Lafayette Building	Philadelphia 3	1630–1700 Walnut St. Building
Birmingham 1	1927 North Fifteth Street	Havana	402 Abreu Building	San Francisco 4	1559–200 Bush Street
Boston 10	1029–201 Devonshire Street	Houston 2	2130 C. & I. Life Building	Seattle 1	1330 Henry Building
Chicago 6	2116 McCormick Building	Los Angeles 17	1526 General Petroleum Building	Tulsa 3	1620 Hunt Building
Cleveland 15	2215 Guildhall Building	New York 6	3310–165 Broadway Building	Washington 6, D. C.	1135 Cafritz Building

REPRESENTATIVES AND LICENSEES

Horton Steel Works, Fort Erie, Ontario, Canada
Ateliers et Chantiers de la Seine Maritime, Paris, France
Constructions Metalliques de Provence, Arles sur Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348 Caracas, Venezuela
Sociedade Chicago de Construcoes Ltda., Av. Franklin Roosevelt 194 S/ 704 C Rio de Janeiro, Brazil
Compagnia Tecnica Industrie Petroli, Rome, Italy
Whessoe Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Comprimo N. V., Amsterdam-O., Netherlands

WELDING LABORATORY—Center of research covering electrodes, procedures, processes, and equipment. Special equipment is available to determine the best procedures for shop and field welding. Extensive tests are made to adapt new procedures to automatic, as well as manual application.

METALLURGICAL LABORATORY—Heat treating section where investigations are run to determine proper heat treating procedures. Other sections are available for metallographic examination, hardness and accelerated corrosion testing.



SPECTROGRAPHIC and **X-ray diffraction equipment** is used for exacting analysis of materials and manufacturing processes. They are also used in special investigations relating to heat exchanger research projects.

A. O. Smith Heat Exchangers

for every service!

PHYSICAL LABORATORY—This laboratory has complete facilities for performing tests necessary to determine exact physical properties of all steels and alloys used in heat exchanger manufacture.

Your heat exchanger problems are solved at A. O. Smith by top-flight engineers and technicians in metallurgical and welding research and by specialists in heat exchanger design.

The quality of the materials selected is maintained by meticulous control procedures in our spectrographic and physical testing laboratories.

Heat exchangers are made and assembled under strict shop quality control, using the most modern machine tools and other mechanical equipment. A. O. Smith has the experience and equipment to perform any necessary test before the finished exchanger is shipped.

There is no limitation on A. O. Smith heat exchanger sizes, temperature or pressure ranges except those imposed by the properties of the materials used.

INDUSTRY COMES TO A.O.SMITH WITH HEAT EXCHANGER PROBLEMS

Research and Engineering Building

78½ YEARS OF PROGRESS

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New York 17 • Philadelphia 3 • Pittsburgh 19
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International Division: P.O. Box 2023, Milwaukee 1

(To obtain more data on advertised products see page 248)

An engineering skill that's hard to match . . .

We mean the skill that's acquired after rolling up sleeves 600 times or more—to design and construct that many petroleum refining, petroleum chemical and chemical plants at sites all over the world.

These plants didn't just happen. Lummus men had ideas, practical imagination, the ability to work, a sharp sense of responsibility, and a company policy which placed no limit upon the physical facilities needed to do the job.

All this is worth its weight in gold—an appraisal which our clients express time and again. We see it as a healthy "atmosphere" in which new processes, new techniques, new equipment and new products are developed to our own high standards, and to the satisfaction and profit of our customers.

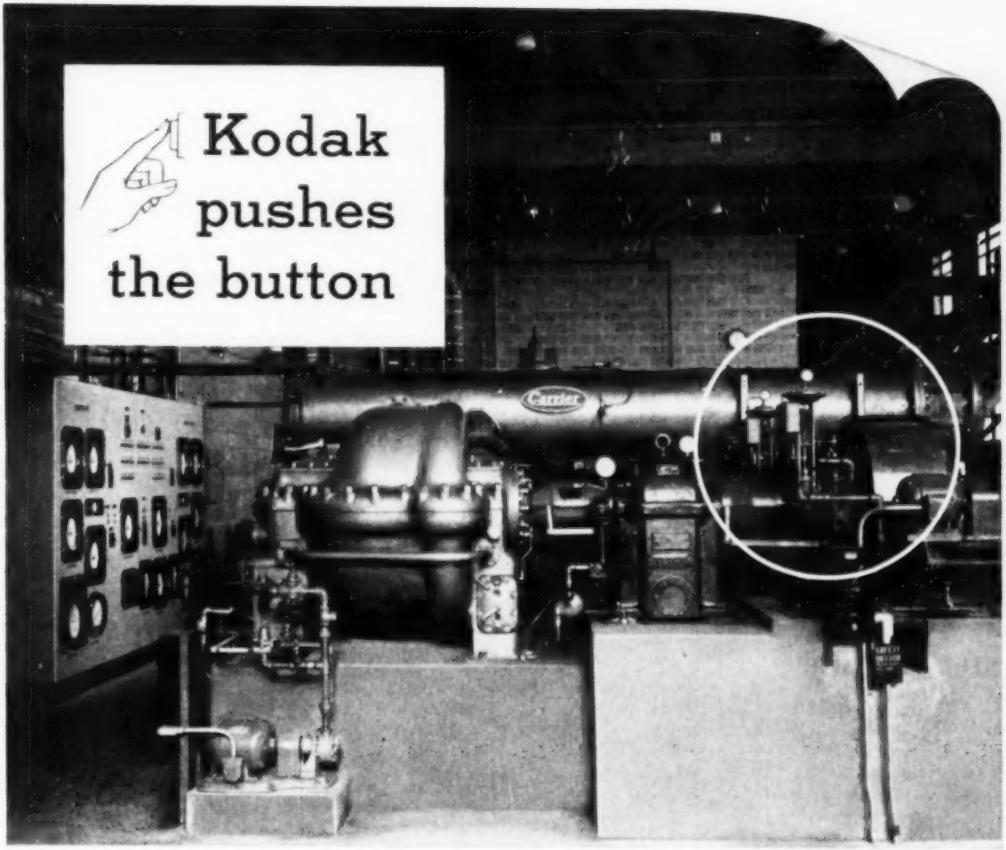
So we offer this suggestion: put us down as a group with the depth of chemical engineering talent and the breadth of experience to tackle *your* next engineering and construction project —whatever and wherever it may be. And to do it with a skill that's hard to match.

THE LUMMUS COMPANY

385 MADISON AVENUE, NEW YORK 17, N. Y.

HOUSTON • CHICAGO • LONDON • PARIS • CARACAS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES



We do the rest . . .

in controlling the refrigeration system at Kodak's huge new Distribution Center at Rochester, N.Y.

This center handles practically every Rochester-manufactured Kodak product for storage, packing and shipping. Efficient air-conditioning is extremely important in the storage of sensitive photographic films and papers.

The refrigeration unit, shown above, consists of two 250-ton Carrier centrifugal compressors driven by a constant speed electric motor. These compressors supply the chilled brine to the Taylor controlled zones.

Taylor controls keep the output temperature of the chilled brine constant by regulating the compressor speed through the oil volume in the hydraulic coupling circled between the compressor itself and a constant speed motor. During periods of minimum load, an ingenious hot gas by-pass induces a load on the compressors to eliminate surging and keep the system fully automatic. From Friday night to Monday morning, when the load is especially light, the system automatically keeps the brine temperature constant with *no manual attention* whatever. "The most fully automatic compressors we have ever installed" say Carrier engineers about these Taylor controlled centrifugals.

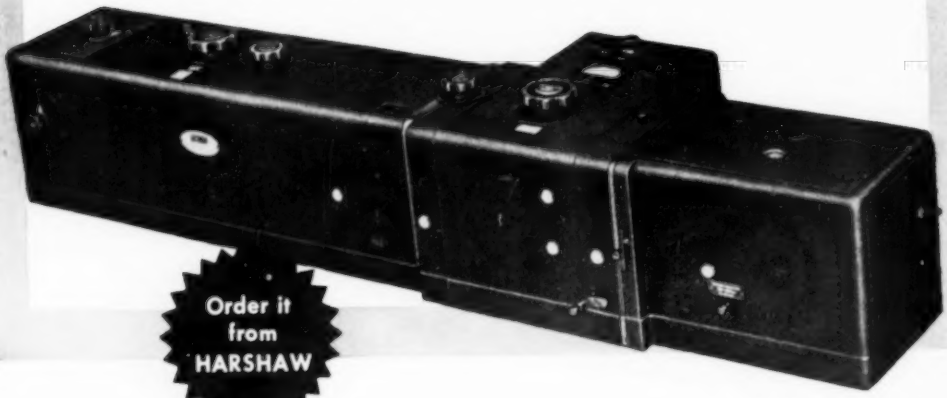
Whether your compressor is reciprocating or centrifugal—driven by an electric motor, steam engine, steam turbine, or gas, Taylor offers automatic compressor control. Ask your Taylor Field Engineer, or write for **Catalog 300.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, fluid and humidity

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

BECKMAN *Model* IR-2

Infrared Spectrophotometer



Order it from HARSHAW

The Model IR-2 Infrared Spectrophotometer is unsurpassed for accuracy, convenience, and overall usefulness in research investigations, analytical laboratory determinations and for the continuous automatic control of plant streams.

Many design features contribute to the convenience and speed of operation of the IR-2. Elimination of zero drift and non-linearity through the use of chopped radiation and an a-c amplifier; minimized stray energy by advanced optical design and employment of a filter-beam chopper; construction in separate compartments, making the IR-2 the most adaptable instrument available; incorporation of a turret-stop mechanism for quick, accurate setting to predetermined wave lengths; collimation of the radiation beam so that the focus is unaffected by substituting special cells of various lengths; direct calibration of the monochromator in wavelength units to eliminate conversion charts; dual gas cells independently filled and positioned without removal from their compartment.

The Beckman Model IR-2 excells in performance: precise reproducibility of transmission measurements; high resolution of better than 3 cm^{-1} at 10 microns; reduction of stray light to less than 1 per cent at 14 microns and to less than 2 per cent at 15 microns; excellent reproducibility of slit and wavelength settings; constant energy output of the source; linear detecting and amplyfying system not subject to uncontrolled fluctuation in sensitivity.

The instrument's fundamental design is similar to that which has proven so successful in the well-known Beckman Model DU Quartz Spectrophotometer. The model IR-2 is constructed of separate units which are easily assembled and disassembled. A rugged, sealed monochromator mounted in a steel housing is the principal unit. To this are attached three other units in the standard instrument; the light-source compartment, the gas-cell and energy receiver compartment, and the liquid-cell compartment. Because other units such as special radiation sources or receivers, or different cells and cell compartments can be attached as desired, the instrument is readily adaptable to specialized measurements and to the changing requirements of research and plant control.

MODEL IR-25 SPECTROPHOTOMETER. Comprised of three units; the instrument assembly with sodium chloride optics, the electronic amplifier, and the power supply for use on 115-volts, 60-cycles. The instrument is assembled with monochromator and three integrally attached units, the energy receiver compartment with thermocouple, the liquid cell compartment, and the light source compartment with phototube regulator, beam chopper and auxiliary metal fixed gas cell, approx. 27 cm. Other cells listed separately. Direct reading wavelength scale 1.0 to 15.0 microns. Shipping weight 400 lbs. **$4650.00**

Contact Harshaw for all Beckman Instruments

See this instrument demonstrated in Booths 18-19, March 5-6-7, 1952 at the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy. Wm. Penn Hotel, Pittsburgh, Pa.

HARSHAW SCIENTIFIC
DIVISION OF THE HARSHAW CHEMICAL CO.
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McKee builds the plants that produce them

It's virtually impossible to find a place where steel is used without the use of some petroleum product in its production, fabrication or operation. It is just as hard to name a use for gasoline or oil without steel in the picture.

Steel and Oil—these are industry's "inseparables" and they are needed today in greater quantities than ever before.

The McKee organization has designed and built hundreds of plants in the United States and some 25 foreign countries and is now engineering new facilities which will account for a definite increase in the production of iron and steel and petroleum products.

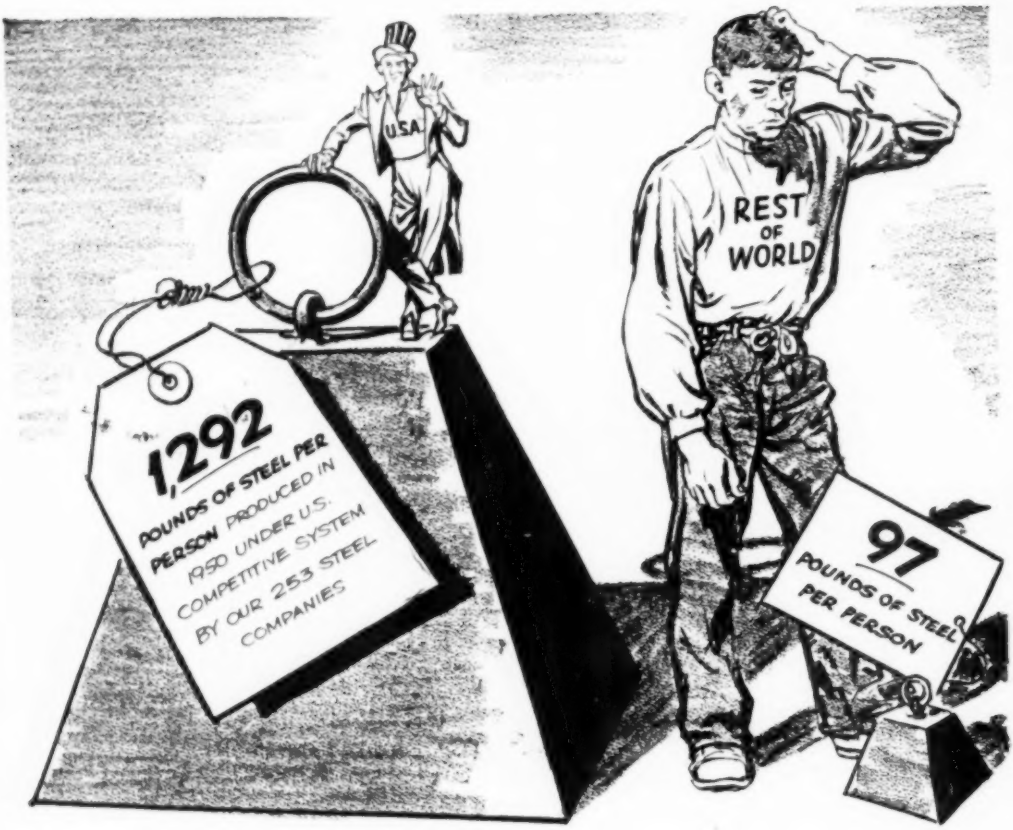
DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

McKee Engineering

Arthur G. McKee & Company · Established 1905

Headquarters: McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio. *New York Office:* 30 Rockefeller Plaza, New York 20, N.Y. • *Washington Office:* 1507 M Street, N. W. Washington, D. C. • *England:* The Iron and Steel Division of Arthur G. McKee & Company is represented by Head, Wrightson & Company, Ltd. *District Engineering Offices:* Union, New Jersey and Tulsa, Oklahoma.

PETROLEUM CHEMICALS DIVISION


USA
REST OF WORLD
1,292
POUNDS OF STEEL PER PERSON PRODUCED IN 1950 UNDER U.S. COMPETITIVE SYSTEM BY OUR 253 STEEL COMPANIES
97
POUNDS OF STEEL PER PERSON

FORTY YEARS AGO the automobile was a rich man's toy. TV and radio were unheard of. Refrigeration? You hung a card in the front window to signal the ice man.

Today we drive 40 million cars, listen to 90 million radios, keep food in 33 million refrigerators.

Yet millions in the rest of the world are still groping in the primitive darkness of 40 years ago.

Why have we moved ahead? Competition is a chief reason. Only competition in business has made luxuries commonplace in your home today. Competition, for example, in the production and sale of steel and things made out of steel.

Steel makes progress possible—in war or peace . . . in the manufacture of everything from tableware to tanks, razor blades to skyscrapers, baby carriages to "Big Mo".

How well does this competition of ours work in the steel business?

. . . The U.S.A. shows an 83.4% gain in steel output between 1939 and 1950. The rest of the world shows an 0.8% loss.

. . . In 1939, the U.S.A. under "competition" made ⅓ of all the world's steel. Today we produce half—all with only 6% of the people in the world.

. . . Steel workers under "competition" gained in jobs, too. There were 449 thousand jobs in 1939. Today—637 thousand.

The steel industry is just one example of how a free competitive system works. Ours is the security millions of people in the world dream of when they embrace such dead-ends as "planned economies".

Look around and see what happens when people hand their jobs and factories over to the government. Or have them taken by law. Or by force. Name it what you will—"communism", "nationalization", "socialism","regimentation"—it is a one-way street, and no turning back. By then people no longer own government. Government owns the people.

• • •

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THE COMPETITIVE SYSTEM DELIVERS THE MOST TO THE GREATEST NUMBER OF PEOPLE

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

February ★ One of a Series of Interest to the Petroleum Industry ★ 1952

Automobile Manufacturers Make Use of DuPont Movie for Service Managers Clubs

Du Pont's movie, "What Makes A Gasoline Good?", was introduced in August 1950 as a means of helping oil companies teach service station personnel more about the basic product they sell. By the end of 1951, 188 prints were in circulation and in continuous demand.

When the film was shown recently to the national service managers of seven of Detroit's large automobile manufacturers, these men immediately recognized its value as an instruction and entertainment medium for their respective district service managers clubs.

It has been found also, that among automobile dealer service personnel, the film is an excellent medium for explaining how gasoline is made, how it is blended for seasonal variation, and what the differences are between regular and premium gasolines.

Oil companies benefit from such showings because automobile mechanics, armed with a better knowledge of the care and research which go into the blending of gasoline, are less likely to blame the fuel for shortcomings that are due to faulty timing, old spark plugs, or other types of mechanical maladjustment.

Has 25 Years Experience in Petroleum Chemicals Research

CHARLES J. PEDERSEN, now a research associate studying the mechanism of oxidation at Du Pont's Jackson Laboratory, was one of the early scientists in America to work on the commercial development of tetraethyl lead. Throughout his 25-year career, devoted almost exclusively to petroleum additive research, Mr. Pedersen has made many contributions to the petroleum industry. In addition to improvements in tetraethyl lead manufacturing, his 29 patents relate to such diverse fields as the development of gasoline antioxidants and metal deactivator. He is also responsible for inventions applying to lubricant additives and corrosion inhibitors for antifreeze solutions.

Mr. Pedersen, who is a member of the American Chemical Society and the American Association for the Advancement of Science, joined the Du Pont Company in 1927 after receiving his master's degree in chemistry from M.I.T.

From Swamp to Blending Plant! . . . Du Pont Helps Marketer Solve Unusual Problem

A large marketer needed a new tetraethyl lead blending plant. But two major obstacles stood in his way. The only site available for the building was a swampy lot near his bulk plant . . . and the area was highly congested with fuel storage tanks. The swamp presented an unusually difficult construction problem, the congestion a fire hazard.

COMPLETED AND READY FOR OPERATION, this modern blending plant was specially designed and built to the customer's particular needs. It is one of many such plants constructed with Du Pont help in the past 12 months.

To the marketer, it looked as if he were stymied so he came to Du Pont for help.

SPECIALLY DESIGNED

Du Pont is always prepared to furnish standard blending plant plans to any refiner or marketer. But this job called for a special design. Fortunately, tough problems like this are part of the daily routine for technical service representatives of the Du Pont Petroleum Chemicals Division and the whole project was planned in detail by Du Pont designers before construction began. Even recommendations for materials and equipment were included in the plans.

Because of the swamp, extra-strong piling was required to support the foundation. First, 19 ordinary wood piles were driven into the ground. These were then reinforced with iron

DU PONT REPRESENTATIVES Arthur C. Santora and Robert E. Holeton discuss plans in detail with the superintendent of construction.

bars and cement. The bars were laid across the top of the piles before the cement was poured into wooden forms built around the piles.

To overcome the congestion problem, Du Pont designers took measures to increase the fire resistance of the blend-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Blending Plant*

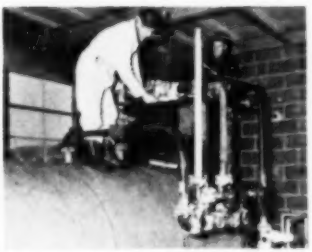
ing building. And throughout the construction a Du Pont representative was on hand to advise the building crew. On such a job, his services include inspection and testing of equipment, as well as advisory help during the construction stages.

PERSONNEL TRAINING

In addition, as a final step, Du Pont representatives are prepared to train blending personnel in the safe and efficient operation of the unit. And for the customer's convenience, special equipment such as scales, weigh tanks, and pipe connections are obtainable through Du Pont.

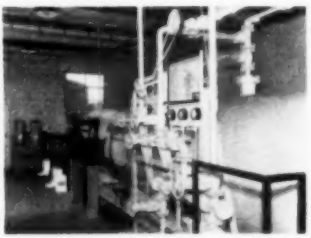
SPECIAL PILING is required for construction in swampy land. It is made by pouring concrete over ordinary wood piles. The cement "caps" are also reinforced with iron bars.

THE BIG WEIGH TANK is eased onto cradle of scales by a crane. Because of the nearby fuel storage tanks, extra fire resistance is built into the cinder block walls.



A CAREFUL CHECK for leaks is made by Du Pont representative Robert Holeton. All valves and pipe connections are first soaped by the workman to make the check absolutely sure.

FINAL INSPECTION by Mr. Holeton helps assure that there is no foreign matter left in tank to clog valves. After this, the tank is permanently sealed for operation and no one is permitted to enter.



INTERIOR OF THE NEWLY COMPLETED blending plant. Extreme care is exercised to keep such plants immaculate since "good housekeeping" and safety go hand in hand in tetraethyl lead blending operations.

Fast, Reliable Tetraethyl Lead Deliveries Assured by Du Pont's "Warehouse-on-Wheels"

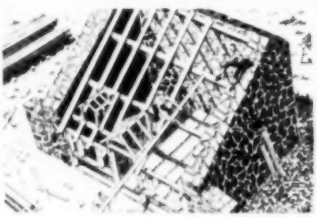
When you need an extra supply of TEL, or want a delivery faster than previously scheduled, there is a Du Pont TEL car already loaded and strategically located at a rail siding ready for delivery to your plant.

For your convenience, and to meet emergency conditions, there are such Du Pont sidings in, or adjacent to, major refining areas. An ample supply of both Motor Mix and Aviation Mix is constantly maintained at these sidings. And there is someone at the phone to expedite your order at any time of the day or night.

Further, to meet the constantly growing customer demand, Du Pont recently expanded its TEL tank car fleet. All these "warehouse-on-wheels" facilities mean that you can receive Du Pont TEL *at your convenience*, rather than according to inflexible and sometimes inconvenient schedules.

Du Pont also maintains fully-stocked Petroleum Chemicals warehouses in Houston and Los Angeles, as well as in Wilmington. A month's supply of the complete line of Du Pont additives is always on hand at these strategically located shipping points.

Du Pont Historical Highlights



Powder mills such as these built by E. I. du Pont in 1802 had never been seen in America. The Du Pont mills were made of extra-heavy stone walls on three sides and flimsy framework on the fourth side and roof. Thus, if an explosion occurred, its chief force would be upward and away from other buildings—an important safety factor.

Such precautions, at the very outset, helped establish the pattern for a continuing safety program that soon placed Du Pont among the leaders in safety procedure.

Long experience in the handling of highly toxic chemicals put Du Pont in a position in 1923 to set up the only safe method for the manufacture of tetraethyl lead compounds.

Today, Du Pont not only maintains an outstanding safety record in its own plants, but also employs a staff of medical and safety advisors on call to help refiners guard the health and safety of their TEL blending personnel.

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Pardon My Ignorance
by Pinet

I thought A CATALYST SUPPORT was a crutch for a tottering tom . . . until I got the facts from Norton

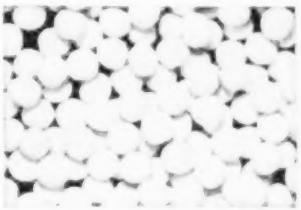
Now I Know:

A catalyst support, to more and more processing firms, means Norton ALUNDUM* spheres, rings or pellets of such purity and chemical stability that they assure end products free from contamination. Their patented controlled structure, high refractoriness and abrasion-resistance promise you greater yields over a longer service life.

In particular, it may pay you to investigate Norton spherical catalyst supports. Made in diameters from $\frac{1}{4}$" to $\frac{3}{4}$", they provide you with such a uniform bed that channelling and pressure drop are reduced to a minimum.

Continuing research in catalyst supports is typical of the efforts Norton engineers are making to fit special refractories to your exact requirements.

So, if you have a high-temperature problem, complicated by chemical, electrical or physical variables, call in your nearby Norton refractories engineer. Or write to Norton Company, Refractories Division, 592 New Bond Street, Worcester 6, Massachusetts. Canadian representative: A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.



NORTON CATALYST SUPPORTS can be supplied in CRYSTOLON*, MAGNORITE*, FUSED STABILIZED ZIRCONIA and MULLITE, as well as in ALUNDUM, compositions. Each has its own special properties as a catalyst support. Each has the chemical stability and purity that eliminate contamination of both catalyst and end product.

NORTON POROUS MEDIUMS are made of ALUNDUM (fused alumina) in a wide range of sizes and shapes in plates, tubes, discs, and diaphragms for filtration, diffusion, aeration and electro-chemical applications. Patented controlled structure makes them uniformly porous. Highly resistant to acid and alkaline conditions.

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Special REFRACTORIES

Making better products to make other products better

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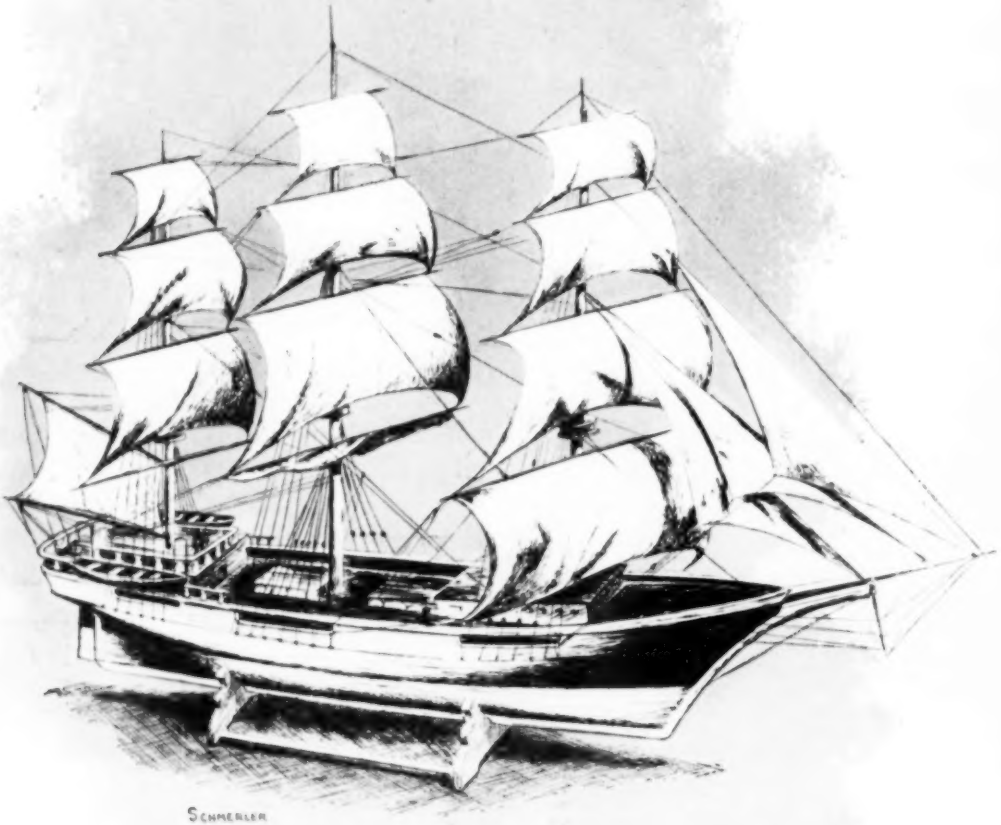
FROM STEM TO STERN



ANOTHER WAY OF SAYING UOP SERVICE IS COMPLETE

Long before the fast clipper ships raced 'round the world for commercial prizes, sailors were saying "stem to stern" and "truck to keel" when they wanted to convey the idea of *completeness*. Today these salty terms are commonly used to express the same idea.

Even more accepted is the association of this thought with UOP Service. Included are all phases of basic petroleum research and process design, engineering, construction supervision, operator training and safety inspections, and assistance on day-to-day problems of plant operation.

UOP Service goes all the way to help licensee refiners operate their plants at greatest efficiency and profitability.

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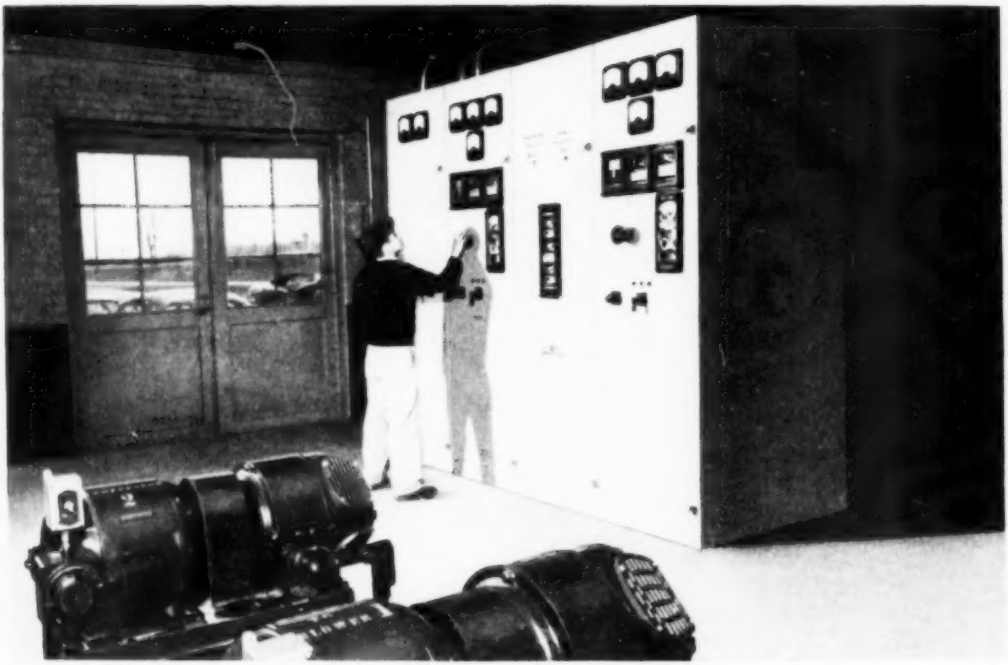
Universal Service Protects Your Refinery

A PHOTO-REPORT ON MODERN

G-E equipment helps cat cracker operate 'round the clock!

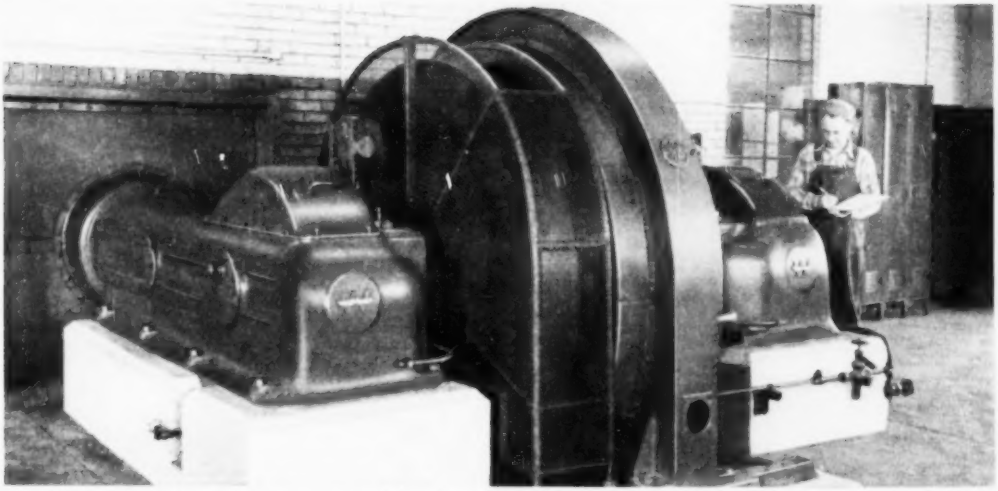
Hazardous and corrosive atmospheres present no problem for plant's G-E explosion-proof motors

As part of a new construction program, Rock Island Refining Corp. recently added a fluid catalytic cracking unit to its refinery near Indianapolis, Ind. Here 12,000 barrels of crude per day are refined into kerosene, naphtha, gasoline and other products. Here G-E equipment—selected and applied for reliable operation in hazardous and corrosive areas—helps keep production going three shifts per day, 24 hours every day! And here, too, is more proof that G-E can handle any refinery electrification problem—including yours. See your G-E representative—early in your planning. *General Electric Company, Schenectady 5, N. Y.*

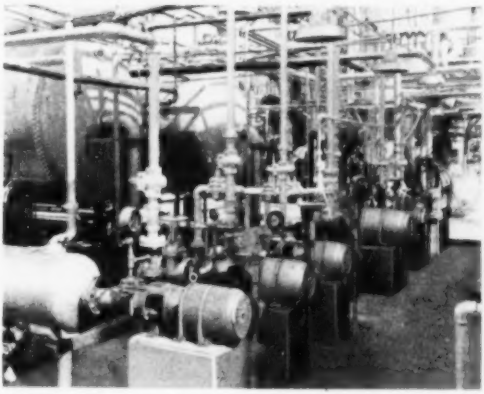


Installed in a non-hazardous area at Rock Island, this G-E metal-clad switchgear—a compact, space-saving unit—controls incoming 4160-volt a.c. power going to two synchronous motors in the refinery. The motor-generator sets, in foreground, supply field current for these motors.

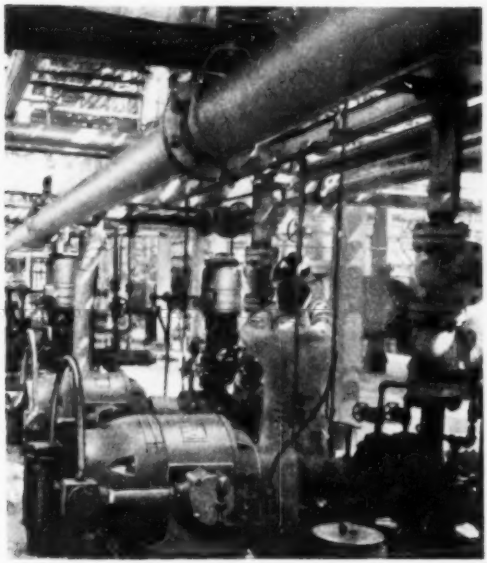
GENERAL ELECTRIC



Proved dependability and minimum maintenance make G-E synchronous motors a top refinery choice. This G-E 400-hp 4160-volt synchronous motor drives two gas compressors in the fluid catalytic cracker.



Five of a kind—all G-E, all totally-enclosed explosion-proof—these motors vary in rating from 2 to 20 hp. They are used to "charge" gasoline and burning oils to Rock Island's treating plant, where objectionable odors and sulphur compounds are removed or transformed.



Corrosion and weathering doesn't harm G-E totally-enclosed explosion-proof motors. At Rock Island, the two G-E 40-hp motors of this type in foreground drive crude charge pumps, while the two G-E 15-hp vertical motors of the same type in background drive pumps charging partially refined oil directly to the cracking unit.

New G-E Motor Selection and Application Course can help train your refinery employees, increase their efficiency. A G-E "More Power to America" program, it shows how motors work, types now in use, how to select and apply them for specific jobs. Write now for Bulletin GEA-4938-16 describing the course in detail.

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ELECTRIC EQUIPMENT

for fluid catalytic cracking

ATTAPULGUS Fullers Earth
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...two reliable names along the path of petroleum processing

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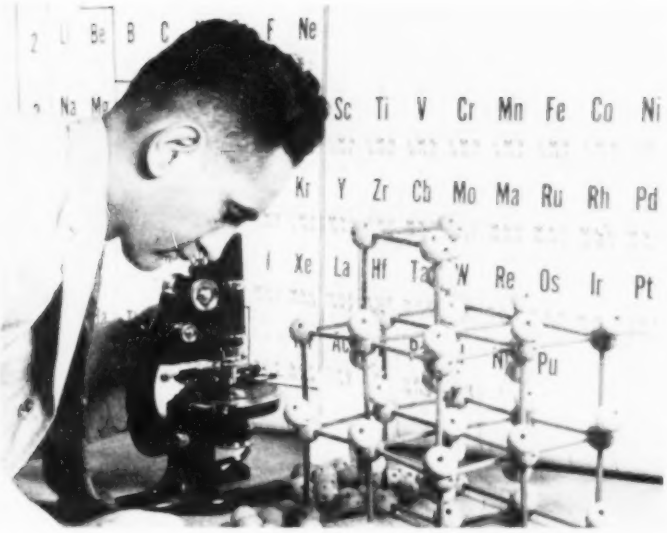


THIS MONTH'S COVER shows a scientist in Sinclair Research Laboratories examining the crystal structure of a catalyst.

Want to Encourage Inventors?

Study 'the Sinclair Plan' for transferring new ideas from individuals to corporations

By RAYMOND F. ADAMS
Counsel, Sinclair Research Laboratories

DESPITE the best efforts of the lawyers, the first corporation capable of conceiving an idea has yet to be created, and the prospect that it will be is dim. We must look to real persons for our new ideas today and for the foreseeable future. Corporate business must find effective means to maintain the fertility of these real individuals and to promote the transfer of their ideas to corporations.

Fifty years ago an individual with an idea for a new product or a new process or a new piece of equipment could with reasonable certainty establish ownership of his idea and transfer that ownership to a corporation. As the proprietor of the idea, the corporation could then, and again with reasonable certainty, realize in commerce on such values as the particular idea might have. But over the years a number of forces have been at work making it both less certain that such proprietorship could be established by the individual with the idea, and less certain that a corporation taking over the individual's proprietorship could realize on it in the world of commerce.

An individual's chance to establish proprietorship has been diminishing as the tools and skills required, even to make measurements, have become more elaborate, more complex and more specialized by reason of our technological progress. The individual, for himself, seldom has access to the necessary facilities.

A corporation's chance to realize on an exclusive right in a new idea has been lessened by endless repetition of the assertion, a mistaken one I think, that bigness in business is badness, a proposition quickly leading to the thought that badness should not be so rewarded.

In terms of economic incentives, I think it is clear that a corporation cannot afford to buy an idea from an individual if the very act of purchase or transfer destroys the value of the idea to the corporation. It is equally clear that too few of us have perceived this connection between the recoverable value of the idea in the hands of a corporation and the recoverable value of the idea to the individual who conceived it.

Everyone seems to agree that a corporation taking an idea from an individual should reward the individual for the idea. Not so many grant that the corporation, having paid the individual for his idea, has the right to make money on it. This inconsistency creates a very real problem.

There are two general forms in which proprietorship in an idea may be asserted: as a right in a trade secret, or as a patent right. I am going to refer to patent rights as the simpler and more familiar form, but I do not thus mean to imply that my remarks are pertinent only to patented ideas.

Before the turn of the century, anyone with an idea had a fair chance of demonstrating the value of his idea on his own. The facilities of the workshop in the garret, or the barn, with some assistance from the pharmacist, the blacksmith or the bicycle repairman, were quite enough to permit individuals to put an idea into tangible form *and* to enable these individuals to demonstrate the value of those ideas so as to sell them to the world of commerce. The vulcanization of rubber, the pin-tumbler lock, telephone, motor

car, phonograph and aeroplane are all examples of how this was done.

Today the advance of our technology has changed this radically. The facilities necessary to establish proprietorship in an idea, to demonstrate a contribution sufficient to sustain the validity of a patent, are seldom within the reach of an individual. As a consequence, by the time a proprietary right in an idea has reached a level of social scrutiny by a legislator or a judge, for example, the proprietor turns out to be a corporation, not an individual.

Thus, as a practical matter, questions as to whether or not a *particular idea* is entitled to a reward always seem to become a question as to whether or not a *particular corporation* should realize on an idea. The fact that a corporation cannot conceive an idea is ignored. Also overlooked is the fact that there is no premise for rewarding the individual who conceived the idea unless the corporation can in turn realize on it. We have even had suggestions in this atmosphere that individuals are incapable of significant contributions, that in terms of today's technology only organized groups are capable of creative thinking.

The man who made the departure from conventional thinking with respect to the transfer of new ideas from individuals to corporations is P. C. Spencer, the chief executive of the Sinclair companies. About a year ago it appeared to Mr. Spencer that one way to make new ideas as a class of property more available and more valuable to corporations was to make them more valuable to the individuals who alone were capable of conceiving them. And, in examining what might be done to apply this thought, it appeared to him that perhaps the major barrier in the path of the independent inventor was a lack of the facilities necessary to prove out his idea. The Sinclair Plan was his answer to this aspect of the problem.

Before I state the essentials of this plan, I must note that it is a departure to the point of being a complete reversal of the usual suggestion system. Such systems normally are frankly aimed at the transfer of ideas from individuals to a corporation in order to put the corporation in a position to make a direct recovery on the idea.

The Sinclair Plan contemplates no such direct realization. Instead, it is intended to make an individual's ideas more valuable *to him* by bringing within his reach the costly facilities needed to prove out the idea. Sinclair too expects to recover, not directly on particular ideas which it may have tested, but because *it deals in ideas as a class of property*. And a particular item of property can have no better relative status than that of the class to which it belongs. If the plan makes ideas more valuable, Sinclair will benefit.

Sinclair has at Harvey, Ill., a new and extensive research and development center designed to handle every phase of such work in the field of petroleum. The laboratories there were built with an eye to the future and as a consequence they have a potential capacity beyond the current needs of the Sinclair companies. These facilities have been made available to work on the ideas of independent inventors.

Sinclair has publicly sought out independent individuals who have ideas within the scope of these facilities but to whom such facilities are normally unavailable, and the company has invited these people to submit their ideas for evaluation by the laboratories.

(Ideas submitted must be proposals for new or improved petroleum products, or for new or improved uses of petroleum products. Ideas outside this field, such as those relating to petroleum production or refining, are not considered.—Ed. note)

Sinclair requires that, in the interest of the inventor as well as itself, ideas to be considered must be protected by a patent or application for patent. When an acceptable idea is submitted, Sinclair proposes a simple agreement specifying a test program to be carried out with its facilities, in exchange for which Sinclair receives a royalty-free right to use the idea limited to its companies. Sinclair receives nothing unless, first, the inventor agrees on a test program and, second, the agreed test program is completed.

The idea remains at all times the sole property of the individual. Sinclair gets no element of control over sale or licensing of the idea, and it receives no participation in any return from sale or licensing of the idea.

Short of carrying out the test program gratis, it seems to me that no more liberal offer could be made. Specifically, it would seem unreasonable to suggest that any corporation should make its facilities available for the development of a claim against itself.

Sinclair is in the oil business, and for this reason the plan is limited to ideas for better petroleum products or for improved applications of petroleum products. That is the area of subject matter to which its available facilities apply. In this particular area, the right of use Sinclair requests will improve rather than impair the values realizable by the individual inventor. It is a peculiarity of the oil business that exclusive specialties do not exist on any substantial scale. Any major product marketed by one company is certain to be marketed by most if not all of the rest. The use by Sinclair of an idea thus submitted ordinarily would open up an industrywide market to the individual.

Now let us look at what the Sinclair Plan does for an individual with an idea but without the facilities for demonstrating its value in the market place, the independent inventor who finds himself stymied by the extraordinary requirements of today's technology. Stated broadly, it makes available to him without cost the same facilities that are available to Sinclair, a corporate enterprise, for this purpose.

If the idea suffers hidden defects, the test work will develop them so that the individual can proceed to correct them or turn his energies to other things rather than pursue the end of a rainbow.

If the idea is sound, the test work gives the individual two very important things. First it gives him data demonstrating that his idea is valuable in practical terms, data he could

Meet the Author

Raymond F. Adams is counsel to Sinclair Research Laboratories, Inc., and has been for more than 25 years counsel to Sinclair Refining Co. He has also represented other oil companies and industrial organizations outside the oil industry, principally chemical firms, in matters involving proprietary rights, patents, trade secrets and related antitrust and business practice matters.

Mr. Adams graduated in Industrial Chemistry from Pennsylvania State College in 1921. He is senior member of the law firm of Adams, Forward and McLean, of New York and Washington. His paper on the Sinclair Plan was presented before the National Assn. of Suggestion Systems, Boston, Dec. 13, 1951.

not get without the plan for lack of facilities. Second, it gives him a measure of the real value of his idea to enable him to get out of it what it is worth.

Thus, the Sinclair Plan carries the individual across this barrier built by our advancing technology. A particular idea accepted has the same potential for its independent inventor that it would have had for corporate Sinclair had it belonged to Sinclair.

The Sinclair Plan was announced last May. The intervening time is too short to enable me to give any examples of individuals who, through use of the plan, started out with an idea and ended up with a valuable commercial property. Sinclair is still at work in its laboratories on the first of the acceptable ideas submitted, but the reception of the plan makes it plain that it has merit.

More than 4000 individuals have taken steps to submit ideas under the Sinclair plan; about 500 ideas have been suggested for examination. The laboratories at Harvey are proceeding with the work involved as quickly as agreements can be reached as to appropriate test programs for acceptable ideas.

In addition, many small corporations with limited facilities have asked if the plan or something like it could be made available to them. Large corporations have asked to be put in touch with individuals submitting promising ideas. Many individuals and corporations have evidenced interest in the possibilities of extending the plan to other fields.

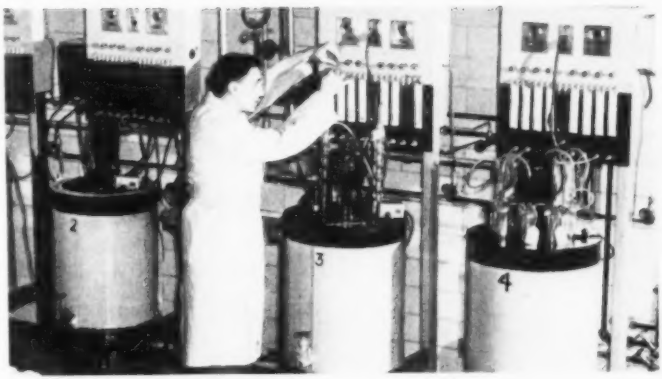
The problems of maintaining the continuing stream of new ideas essential to our economy are not limited to the oil industry. Every branch of American industry needs new ideas and thus faces the same problem and must do something about it. If the premises for the Sinclair Plan are sound, similar plans should be set up in many branches of industry by those with appropriate facilities.

Finally, I can also tell you that the large number of ideas having nothing to do with petroleum products submitted to Sinclair following announcement of its plan satisfies me at least that the plan embodies something which independent inventors as a class are anxiously looking for.

Details Available

Sinclair has prepared an "Inventors' Booklet" giving instructions on how to submit ideas under the Sinclair Plan. Copies may be obtained from the Sinclair Research Laboratories, Inc., 600 Fifth Ave., New York 20, New York.

Sinclair Plan Makes this Equipment Available



EXPENSIVE FACILITIES are needed today to test and prove a new idea but they are far beyond the means of the average individual. The Sinclair Plan makes them available, including such complicated equipment as shown above: **TOP** glass fractionating column, **CENTER** oxidation stability tester, **BOTTOM** corrosion tester. These and other facilities are all located in the company's new research center at Harvey, Ill., put into operation in 1948. Details on the laboratories appeared in the Dec., 1948 issue of PETROLEUM PROCESSING, pp. 1198-1202.

"ON THE AIR" at General Petroleum's Torrance, Cal., refinery. Transmitter-receiver is visible on shelf behind maintenance department dispatcher

RADIO-EQUIPPED TRUCK acknowledges an urgent assignment. Transmitter-receiver can be seen at lower right, mounted below dashboard

Plant Radio 'Network' Saves Time

Speeds up movement of maintenance men, materials, tools in west coast refinery

By D. P. THORNTON, Jr.
Southwestern Editor

RADIO coordination of maintenance operations has passed with flying colors the first half-year of operation at the Torrance, California, refinery of General Petroleum Corp. Upkeep requirements for the equipment have been very low, reception of the new means of communication has been enthusiastic by the men who use it, and extensions of the facilities are under consideration.

Justification of a mobile communication system for maintenance personnel was developed by R. C. McCoy, general maintenance superintendent. He was assisted in the technical phases of the development by one of his men, Elmer Hayes, a "ham" operator in his spare time, who now has charge of the radio installation.

The former situation at Torrance probably can be duplicated in many U. S. refineries. Maintenance personnel are scattered over the plant. Materials, tools and men are constantly being moved by truck between warehouse, job sites, mechanical shops and salvage area. The normal means of communication are the plant telephone, with whistle signals being used to call a man to the phone when he is on the move.

Besides the delays occasioned by mistaking a whistle signal, there was the normal delay which is represented by the elapsed time between needing to communicate with moving personnel and getting him to a phone to answer the summons. This often exceeded five minutes at Torrance.

With the new system there is practically no delay. Instead of pulling the whistle cord the dispatcher calls him on the radio, using a code number permanently assigned to that vehicle. The man answers simply by picking up his microphone, pushing a button on the side of it, and acknowledges the call.

The time saved in the simple function of dispatching materials deliveries alone amounts to 4½ to 5 minutes per call over the "old" way. With from 175 to 200 such calls daily this amounts to 13 to 16½ hours. Saving in man-hours for supervisors, foremen and sometimes whole crews through the use of radio is difficult to estimate, although it is appreciable. In an emergency, even seconds saved may mean much. At the same time, the affected individuals' jobs are no different than before; they simply are performed more efficiently.

There are still other savings besides time, and which may not be readily totted up in dollars and cents. To mention a few: Lost-time mileage in trucks and cars is reduced. A unit down for maintenance may be put back into production sooner. Waiting time for a crew or individual needing transportation to another job, may be reduced.

For example, assume a material truck is reported enroute from one job to the warehouse for reassignment. Meanwhile, a crew has reported a piece of equipment ready to be moved to the shops for attention. By radio it is simple to call the truck and have this chore performed enroute. Not only is the operation performed more quickly, but truck mileage is saved.

Germ of the idea naturally sprang from the growing use of mobile com-

munication among taxicabs, for communication among pipe line stations and the dispatcher, and by local law enforcement agencies. During the war a number of companies equipped their plant guard patrol cars with mobile radio for communicating with a central plant transmitter; this practice has continued and grown in size and variety of application.

The system used by General Petroleum consists of a central station, known as "KMB550", transmitting on 153.11 megacycles (frequency modulation), and six mobile units capable of both receiving and transmitting on the same frequency. Now on order are four more mobile units and an application is pending for 10 "walkie-talkie" receiver-transmitters which likewise will use the same frequency.

When the four new mobile units are installed, the total equipment will be distributed as follows:

- Three "stinger" trucks (flat bed type, equipped with movable boom and winch).
- Three material trucks (with sides and end-gate) used for moving equipment and tools; can carry men when necessary.
- Four automobiles, one each to the two assistant maintenance superintendents in the field; one each to rigger and labor crew foremen.

The walkie-talkies, if authorized, will be assigned to mechanical crafts working on isolated field jobs where telephone communication is not available or would have to be temporarily rigged. Such crews may consist of one or more men.

"STINGER" TRUCK gets call to move heavy materials from warehouse to job. Radio equipment here is mounted in dash in glove compartment space

Equipment

The "works" and appearance of the central transmitter is identical to the mobile units except for slight differences in power supply and auxiliary equipment. Indeed, this was done purposely so that, in event of a plant power supply failure, an ordinary storage battery can be quickly connected in place of the converter (a rectifier supplying 6 v. DC) which permits operation from 110 v. AC. The transmitter is mounted on a shelf in the maintenance department dispatcher's office and probably would escape the attention of the casual visitor.

The speaker and microphone set looks like an ordinary desk telephone except for a pushbutton on the microphone (in lieu of the handset) and a pilot light below the speaker (replacing the dial). The pilot light indicates when one of the other "mikes" is in use. There are now two, one in the dispatcher's office designated as the central station and capable of interrupting any other connected to the central transmitter, and the other in the clerk's office.

Regulations of the Federal Communications Commission require keeping a log by the station operator (the dispatcher) open to inspection at all times. Individual messages are not logged, but the daily operating period when facilities are in use must be shown, plus any repairs necessary. Likewise, outages are shown, and reports of interference either from "outside" sources or complaints against the station itself. Also, central station operators must be licensed (they need not all be qualified repairmen).

Included are frequency checks, to see that all transmitters remain on the assigned frequency and do not "drift". It is a further requirement that, at least every 15 minutes during the operating period, the central station must announce. This is to permit frequency checks by FCC inspectors and as an aid in identification should interference with other licensed transmitters develop in the area.

The station antenna is of the "ground-plane" type, mounted 10 ft. above the roof of the maintenance department office. Its effective length is dictated precisely by the assigned frequency of the station and is so located that every part of the refinery can be "seen." This is necessary because so-called "FM" transmission is in a straight-line.

The mobile receiver-transmitters are entirely self-contained units, without power supply, mounted on the dashboard, usually in the hole left by removing the glove compartment of the vehicle. Commercially they are known as the "Motorola front-mount uni-channel mobile dispatch unit." The power consumption when transmitting is approximately 30 amps. at 6 v. DC; when receiving about 6 amps. are required. Normal range, depending on terrain and an-

Principal Manufacturers of Mobile Radio Equipment

For those interested in studying the applicability of mobile radio communications in their individual plants, following is a list of principal suppliers of this type of equipment. There also are numerous organizations who lease equipment, authorizing a customer's employees to act as their agents in operating the facilities.

Belmont Radio Co. Div., Raytheon Mfg. Co., Chicago.
Collins Radio Co., Cedar Rapids, Iowa.
Communications Equipment Co., Coral Gables, Fla.
General Electric Co., Electronics Dept., Schenectady, N. Y.
Link Radio Corp., New York City.
Mobile Communications Co., Long Beach, Calif.
Motorola, Inc., Chicago.
Northern Radio Co., Seattle, Wash.
RCA Victor Div., Radio Corp. of America, Camden, N. J.
Western Electric Co., New York City.

tenna elevation is approximately 20 miles.

There are only three controls: the "mike" switch previously mentioned and used to turn the transmitter on and off, an on-off and volume control combination which operates the set and controls speaker volume, and a "squelch" control which effectively renders the speaker inoperative except when a message is being received. Thus the operators at base or in the trucks do not have to listen to "background" noise all the time the set is on. There is nothing to fiddle with and distract the operators' attention when driving; he simply picks up the mike and depresses the button when he wishes to speak, releases it when he is through.

The usual truck or automobile generator is inadequate to keep the battery charged under the power drain imposed by the transmitter, and the constant operation of the receiver at all times when the truck is in service (standing or running). The replacement generator used, which has proved very satisfactory, is a Leece and Niebell 3-phase alternator rated at 30 amperes, belt-driven off the fan. The output is alternating current which is rectified at high efficiency to direct current at 6 v. Connections to the truck wiring otherwise are entirely conventional. The arrangement can furnish up to 60 or 70 amperes for short intervals without damage, and will supply operating power for the mobile radio without significant drain on the battery even when the vehicle engine is idling.

The mobile sets are held in place by a locking device, the key to which is held by the repairman responsible for their operation. This effectively renders the sets tamper-proof and, since all connections are enclosed, no safety hazards are introduced.

The mobile sets, including special generator, can be installed in a vehicle for approximately $500. The central station will cost slightly more because of antenna erection and auxiliary equipment. Without special arrangements which are not used at Torrance, the equipment may not be connected to regular telephone lines.

How System Works

Since FM radio is a line-of-sight proposition and there is much lofty steel equipment in a refinery, it might at first be thought there would be many areas wherein radio communication would be effectively blanketed. This is not true with the high frequencies used, although definitely correct if a frequency in the broadcast band was used.

In order to blanket a radio signal, it must be absorbed. So high is the FM frequency the wavelength is measured in inches, instead of feet as in the usual audio modulation broadcast bands, the signals literally pass through the "holes" in most refinery structures without noticeable impairment, although the volume may drop in areas remote from the transmitter.

This was vividly demonstrated to the writer during a recent plant visit. First, a material truck was called to base to illustrate central station operation. On arrival communication was had with the base transmitter less than 50 feet away. Controls were not disturbed thereafter.

Then, this radio-equipped truck was driven through the process area, meanwhile frequently communicating with base and also confirming that reception from the truck transmitter remained good. Next, the truck was parked between two large TCC cracking units, separated from each other only by a narrow roadway. The refinery central base station was "behind" one of the units, while overhead were the usual racks of pipe, electric wiring and the like. On both sides were other plant facilities. Communication with "base" was excellent despite the noise from the nearby regeneration air blower, and likewise with several other mobile units at their tasks in various areas elsewhere in the plant. In fact, by this sound the base operator deduced the truck's location.

The same experience was had at the refinery tank farm, at the farthest possible distance from the central transmitter. Here the truck was parked at the fire wall behind (with respect to "base") a filled crude tank, outside the adjacent plant fence was a high-voltage power transmission line. Admittedly it was a poor spot for good reception. For the first time, "background noise" was appreciable but did not interfere with two-way reception.

At times the plant transmitter has communicated with one of its mobile units on special assignment outside the refinery. At Terminal Island, nearly 20 miles away, good communication can be had.

The only probable "dead spot," according to plant personnel, might be inside a well-grounded sheet-iron building or inside a steel storage tank. At no point in the plant where the mobile units operate has any trouble been experienced.

Maintenance difficulties to date have been minor. The system is in use at least 8 hours daily and during major maintenance jobs this may stretch to 24 hours. It has been necessary to replace tubes occasionally, and once an important component of one of the mobile transmitters went out. It also is necessary, as previously mentioned, to periodically take units out of service briefly for calibration checks as required by FCC regulations.

It was not necessary to purchase any special equipment for maintaining the system beyond a special calibration-checking device. The balance of equipment needed is the same as used by any radio repairman and was already on hand due to the fact that various electronic control instruments are in use in the refinery; the equipment to test them also can be used for mobile radio.

The men who use the sets like them. They have not been regarded as a means for supervisors to "spy" on the men or keep closer check on their activities. Instead, the men feel that they have been given one of the most modern of tools for the workmanlike performance of their jobs, and are proud of the equipment.

One of the early difficulties was teaching users how to hold the microphone in transmitting. The common tendency is to "swallow" it, holding too close to the mouth, resulting in indistinct, definitely distorted speech transmission which is difficult to understand.

The technique used is very simple and soon becomes automatic. The operator is told to grip the mike with his fingers and base of the thumb, using the index finger to depress the transmitter button only while speaking (because the speaker is automatically disconnected when the set is transmitting, to prevent feed-back howls). The thumb is extended so the tip is in contact with the lower lip at the corner of the mouth. This puts the mike at an angle to the side of the mouth, sufficiently removed so that breath sounds and overmodulation distortion are minimized. Normal speech is used; no shouting is permitted; profanity invites legal penalties.

Other Possible Applications

It is possible the system could be applied to process operations also, supplementing existing telephone links. Remote switching of field tanks might well be directed by unit operators. The laboratory could ask the sample truck to pick up special samples when needed. Roving supervisors could be contacted readily when necessary. Supply trucks could be dispatched from point-to-point without lost motion.

Use of the system in emergencies has tremendous possibilities, too. Being difficult to sabotage, all plant communications could not be paralyzed. If disaster struck, fire fighting, first aid, and repair crews could be dispatched and directed flexibly and quickly from any convenient point. In a pinch, anyone could operate the system after a few moments of instruction.

Equipment may be purchased outright, as General Petroleum has done, or leased. In the latter case, it is reported, equipment is operated by company personnel who are made agents of the licensor for the purpose.

Soap Structure of Lubricating Greases Revealed by Electron Microscope

By RALPH R. MATTHEWS
Special Correspondent

STUDIES of the soap structure of lubricating greases have been greatly accelerated by the development and application of the electron microscope, according to information revealed at the annual meeting of the National Lubricating Grease Institute in Chicago, Oct. 29-31.

Back in 1936 a report was made on the results of a study of the structure of lubricating greases by means of a microscope using thin films with dark field illumination. At that time the resolving power of the best available microscope was only strong enough to show the structure of soap fibers in sodium soap lubricating greases. However, according to that report, "the evidence indicated that all lubricating greases owe their peculiar plastic properties to the fiber structure of the soap particles which permeate and support the mineral oil component."

Dr. B. B. Farrington deserves much credit for initiating the above research, which pointed the way toward the development of more uniform and efficient lubricating greases. However, further work was delayed until the development of the powerful electron microscope. Using it, data was accumulated and a paper presented at the 1947 annual meeting of the National Lubricating Grease Institute. It fully supported the earlier work, and also showed that other types of lubricating greases had definite soap structures — such fiber structure varying with the type. This aroused wide interest because if a control test could be developed, and used quickly enough, production of better greases would be assured.

The N.L.G.I. Fellowship

In succeeding years more research followed and thus when NLGI sponsored a fellowship at the University of Southern California it naturally followed that work with the electron microscope was started at once. Some of the results of this work were reported at the 1951 meeting, in the paper "The Structure of Gels of Hydrous Calcium Stearate in Cetane; Rheological Studies and Electron Microscopy", by R. D. Vold, H. F. Coffer and R. F. Baker of the Department of Chemistry and Electron Micrope Laboratory of the above university.

Slides showed the yield value of gels of calcium stearate monohydrate in cetane as a function of time of mechanical working, starting with both quenched and slow-cooled systems. They also showed the effect of water content and aging on the yield value. Electron micrographs of the samples showed structural changes due to working, hydration and time.

The samples for electron microscopy were prepared by slicing frozen blocks of the gel into sections of 0.05 — 0.1 micron thickness (0.000003 in.). Comparison was also made with samples prepared by smearing the gel between glass slides, and removing the cetane by various procedures.

Preparation of the slices is very cleverly done by heating the sample and then freezing it. A microtome blade is used in making the slices, which are floated away on cooled water. The slice is then collected on a collodion-coated screen, the cetane removed by vacuum evacuation, and the resultant film bombarded with electrons.

"The most important result of this work is the demonstration of the existence of an irregular, mesh-like structure in a particular system and its direct relation to the consistency and stability of the system. Consequently, an attractive further development is in the direction of ascertaining to what extent this phenomenon is characteristic of other types of lubricating greases and to determining the connection between the observable structures and changes in yield value or stability resulting from such variables as rate of cooling, tempering temperature, age hardening, and incorporation of additives to affect crystal habit. It is also a question of considerable interest and importance as to whether this mesh-like structure results from actual growing together of the particles, as in a sponge, or from a looser mechanical effect, as in a log jam or brush heaps.

"A second group of projects which is becoming feasible involves attempting to verify the existence of the mesh-like structure independently and attempting to devise quantitative expression and experimental test for some of the hypotheses here advanced."

Soda Base Lubricating Greases

Dr. A. Bondi also presented a digest of a paper on structure of soap fibers in soda-base lubricating greases prepared for the Third World Petroleum Congress, The Hague, Holland. It was titled "Developments in the Field of Soda Base Lubricating Greases" and represented the cooperative work of J. P. Caruso, H. M. Fraser and J. D. Smith of the International Lubricant Corp. of New Orleans, La., also A. Bondi, S. T. Abrams, A. M. Cravath, R. J. Moore, R. N. Moore, W. H. Peterson, A. E. Smith, F. H. Stross, E. R. White and J. N. Wilson of Shell Development Co. at Emeryville, Calif.

The variations, using pure soaps and mixtures of them with pure and mixed hydrocarbons, were studied using the electron microscope, and yielded information supporting the work of Dr. Vold. With soda-base lubricating greases the average ratio of the length of the soap fibers present was found to be an important factor governing the consistency at a given soap concentration. The brush heap structure of the fibers holds the oil in its interstices by capillary force — the ability of it to resist deformation increases with fiber length. The viscosity of the oil also is a factor in determining consistency.

Sheer stability was found to depend on the strength of the individual soap fibers and their tendencies to be broken into shorter fragments causing lighter consistency, or into thinner fragments with resulting heavier consistency. On a friction testing machine the wear was more after addition of soda-soap base than on the straight oil. The structure of the soda-soap base is affected by the rate of cooling but not strengthened.

Bondi concludes: "The empirical selection of raw materials and processes will no doubt continue to be the important route to future lubricating grease developments — but progress along this route will be facilitated by the knowledge of the structure of soap-base lubricating greases and of the relation of that structure to the useful properties of the lubricating greases."

Lithium Lubricating Greases

The third paper on soap structure of lubricating greases was from the Sinclair Research Laboratories, Inc., and by John A. Brown, Charles N. Hudson and Lewis D. Loring. The title: "Electron Microscope Study of Lithium Lubricating Greases."

This work was all on lithium soap lubricating grease. A special procedure was used in preparing specimens for inspection with the electron microscope; it was carefully checked to be sure the fiber structure was not modified using the method as compared to the true structure.

Testing lithium lubricating grease

made with various fats and fatty acids showed conclusively that the fiber structure varies with the type of fat used in the manufacturing process. As was anticipated, it was found that the larger fibers produced the most rigid gel structure. An investigation of the effect of heat showed fiber formation is aided by heating to a temperature near the solution point where well-defined fibers are able to be formed. Oxidation in a Norma Hoffman bomb at 177° F. for 177 hrs., using a copper catalyst showed no soap fibers remaining when tested in the electron microscope.

From a practical and service angle, the effect of severe mechanical working on the grease fiber structure is most important. Using a wheel-bearing tester, samples were examined taken from the actual surface of a bearing. It was found the soap structure had been almost entirely broken down. Further, it was learned such change could take place in as short an interval as 30 min. Not any of the testers such as the ASTM worker, the Navy worker, a colloid mill, nor the Shell roll tester caused so severe breakage of the fiber structure as was caused by use on a roller bearing.

The authors summarize as follows: "The information gained thus far in this preliminary investigation of lubricating greases by the electron microscope has given an insight into the true structure of lubricating greases. This knowledge is of great value in the formulation of new and better lubricating greases—and the electron microscope has thus established itself in our laboratories as an important tool in lubricating grease research." This statement indicates it will be some time yet before that microscope can be adapted to control work in manufacturing greases.

Oscar Maag, of Timken Roller Bearing Co., commented that practical service tests made on lithium lubricating grease show the fiber structure has a bearing on service life. It appears the use of a higher viscosity oil provides best lubrication over a longer period; however, tests are now being made comparing lithium soap lubricating greases containing low viscosity and higher viscosity lubricating oils.

This One Is Really Expensive

Another paper of interest was entitled "Phthalocyanine Lubricating Greases." It was prepared by R. L. Merker, C. R. Singleterry and V. G. Fitzsimmons, Naval Research Laboratory, Washington, D. C. In preparing this type of lubricating grease, copper phthalocyanine was used in densifying the liquid lubricant. This compound has a ring structure—probably in more than one plane—and that may account for its value in preparing lubricating greases.

Heat Resistance—Using silicone fluids, phthalocyanine lubricating greases were made which could not be broken down by heat as high as 250° C. (482° F.). That is exceedingly higher than had been possible previously when other soap bases were used with such fluids.

Shelf-Life—The shelf-life of bearings of motors and other machinery parts which are pre-lubricated does not usually exceed three years. Tests made thus far indicate phthalocyanine lubricating greases made from either mineral or synthetic oils have exceedingly good stability over a long period. Thus they will be of great value for pre-lubricated bearings.

Life Time Lubrication—In view of that stability, it is anticipated life-time lubrication of bearings will become a reality this when synthetic diester oils are densified by copper phthalocyanine.

The present cost of copper phthalocyanine of approximately $10 lb. will limit application of the lubricating grease to special cases—or to use by the government where cost is generally not given serious consideration.

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(1) Farrington, B. B. and Davis, W. N. *Ind. Eng. Chem.*, 28, 474-6 (1936).
(2) "An Electron Microscope Study," *The Institute Spokesman*, Vol. XI, No. 1, April 1947.
(3) Proceedings of the Third World Petroleum Congress, The Hague, Holland, 1951, Vol. 7.

Reprints on "How to Order Equipment"

So much interest has been shown in the "How to Order Equipment" series which ran in the last six issues of PETROLEUM PROCESSING, that the editors have now had additional reprints made up of each article. We will be glad to send you single copies of any or all of them—without charge. Price quotations for quantities will be furnished on request. Be sure to specify which ones you want—valves, pumps, heat exchangers, instruments or compressors.

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$7200 FOR ABOUT 230 TONS OF SCRAP came out of these old batch stills; another set of the same type will yield 300 tons more

Scrap Drive with a Profit

By **WILLIAM C. UHL**
Equipment Editor

CAN a refinery scrap drive really make a worthwhile contribution to the nation's critical metal shortage? The answer—an unqualified "Yes"—has been proved by Sun Oil Co.'s success in a "guinea-pig" operation to demonstrate what the petroleum industry can do.

Beside meeting the obvious primary aim of a scrap drive, the company made a small profit in selling scrap to dealers at $31 to $32 a ton. In addition, many indirect "plus factors" were attained: more efficient opetations, improved safety conditions and better plant appearance.

A total of 8000 tons of steel and 70 tons of copper and brass scrap, Sun's company-wide goal in both manufacturing and production, was reached by the end of 1951. The project began late last June when Sun was asked by the Scrap Committee of the American Iron & Steel Institute to inaugurate a pilot operation for the entire oil industry. With some additional scrap still to be obtained, Sun plans to continue the campaign to mid-March.

How was this accomplished? How were the profits and extra benefits realized? To find out, PETROLEUM PROCESSING talked to Paul D. Barton, chief engineer for Sun, who directed the project, and then went down to Marcus Hook, Penna., to see the results in the Sun refinery there, both in the actual plant areas and on the account books. Here's what had taken place at Marcus Hook, as of January 15, 1952:

Credits

Steel scrap collected	3120 tons
Brass scrap collected	19 tons
Copper scrap collected	13 tons
Total scrap collected	3152 tons
Scrap sold for (approx.)	$100,600
Equipment & material salvaged, (approx. value)	$15,400
Total income from Scrap Drive	$116,000

Debits

Cost of removal of scrap	$55,000
Cost of building demolition	$51,000
Total costs	$106,000
Net profit, overall	$10,000
Net profit, scrap only	$61,000

A very good pay-off, just on the scrap metal drive alone, but that wasn't all. Many old buildings were razed and foundations dug up to clear ground areas for neater housekeeping and possible future use. Un-measured tons of brick and concrete rubble from these buildings enabled Sun to fill in land along the refinery river front, gaining a strip of new land 60 ft. wide by 800 ft. long. This was topped with fill dirt and then asphalt paving to provide a new parking area for about 160 more automobiles. In addition, some of the sites where buildings were razed have also been converted to new parking space.

No attempt was made to estimate the value of this gained property. However, the Marcus Hook maintenance and construction department assured me that rubble was virtually impossible to get in the vicinity.

The salvaged equipment and material, conservatively estimated at some $15,400 worth, included many items which went into immediate use. A quick breakdown shows it included:

Seamless steel pipe: 93 tons of 4 to 10-in. All of the larger size, 8 and 10-in., is going into service as piling for new plant units now underway. The 4 and 6-in. is going to be used as supports for overhead piping.

Steel plate: 71 tons of 3/16-in. from dismantled tanks. This material is ready for use. About 55 tons of it had to be rolled flat and trimmed before going to storage.

Structural steel shapes: 64 tons of channels and I-Beams from a dismantled warehouse.

Steel trusses: 3 34-ft. spans, about 1½ tons total.

Lumber: 111,000 board ft., much of it suitable for concrete forms or for scaffolding.

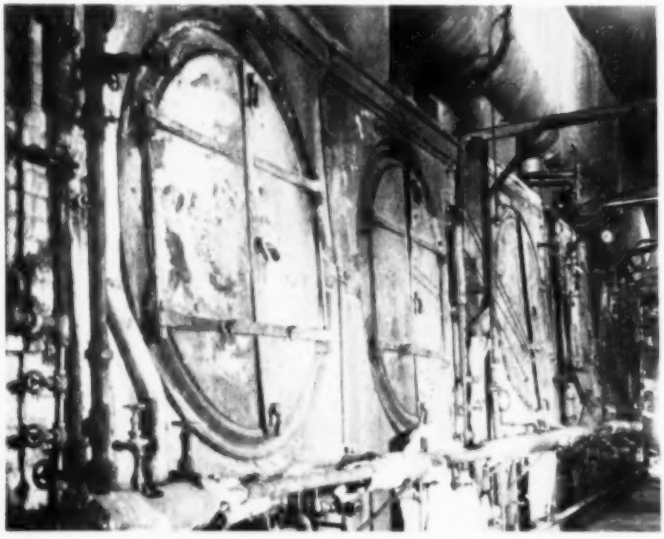
Beyond these, 14 electric motors, 12 pumps, and miscellaneous electrical equipment were salvaged. These are not included in the overall estimate because of the impossibility of arriving at a fair value.

THREE STEEL TRUSSES, MORE PARKING SPACE, besides 150 tons of scrap—from this obsolete boiler house. Left, during dismantling; right, job's done

Where did this scrap come from? How was it chosen? How was it handled? Most of the scrap came from obsolete buildings and process units, storage facilities, and the like. Some units might have been permitted to stay idle where they were or perhaps remain in service another year or two. But the company decided on immediate action because of the urgent needs of the nation's scrap shortage. Comparatively little of the material assigned to scrap was the conventional type refineries collect in daily routine clean-ups.

The 31 different items on the Marcus Hook scrap project list included:

1. Pumps, parts, piping, etc., in seven or eight different buildings.
2. Stacks, boilers, piping, and accessory equipment, two boiler houses proper, and adjacent areas.
3. One complete warehouse and a portion of another.
4. Drum cleaning equipment.
5. Several heavy oil agitators and acid sludge kettles.
6. Filtering plant equipment.
7. Batch still condensers.
8. Several process combustion cases.
9. An obsolete drum conveyor.
10. Tons of miscellaneous piping, supports, and the like.



THIS OBSOLETE BOILER EQUIPMENT, taken out of the building shown in the pictures above, was sold as scrap

Some typical "yields", as described by Marcus Hook personnel, were interesting. For example, one of the two boiler houses produced about 150 tons of steel which sold for $4770. The cost to remove that scrap was $5735, including straight labor, materials (truck hire, crane rental, cutting torch gas, etc.), and overhead charges. In addition, demolishing the building itself and the stack and removing the rubble cost $5978. The stack had to be taken down carefully because of the close proximity of other structures. So on that particular item, Sun "lost" money.

The other boiler house yielded 180 tons of scrap, for an income of about $5700. Scrapping costs were $5270, and demolition, $3283. In this case the stack was dynamited down since there was sufficient space around the boiler house. But, again this was a "loss," although three duplex steam pumps were salvaged.

On the other hand, 1770 tons of readily accessible miscellaneous scrap pipe and other obsolete items were obtained for a cost of only $6,000 and a gross income of approximately $56,000. Net gain: $50,000.

Three old pump houses and motor rooms yielded an even balance. It cost about $2226 to scrap the 64½ tons of metal at these locations, which sold for $2000.

Submerged coil condensers and associated piping, part of a set of old batch stills, yielded some 230 tons of scrap, and an income of $7200. The cost in this case, $8485, was considered relatively high, but was caused by the crowded conditions surrounding the equipment to be taken down. Another batch still of the same type, soon to be scrapped, will produce an estimated 300 to 400 tons more, Sun officials said.

"To Be or Not To Be—Scrap?" What factors decided whether equip-

111,000 FT. LUMBER, 64 TONS STRUCTURAL STEEL SHAPES were salvaged from this worn-out warehouse. Left, during razing; right, job's finished

ment was to be scrapped? Top officials—Mr. Barton, the manager of refineries, the assistant superintendent of maintenance and construction, and the warehouse superintendent — made a complete tour of the entire refinery. Warehouse assistants accompanied them, bringing detailed data, costs, book values. The inspection group examined each piece of equipment and accumulation of metal. They asked themselves, and they questioned the records: Is this necessary for plant operation, or to insure operations?

If the answer was positively yes, the group went on to the next item. If the answer was positively no, the item was assigned to scrap without further question.

If the answer was maybe, the officials discussed the problem immediately. They decided whether it could or could not be regarded as potential scrap. If it was potential scrap, several further factors had to be weighed: (1) How much work is involved in dismantling the equipment? (2) Must the unit be replaced, and how soon? (3) Will other process equipment have to be re-arranged?

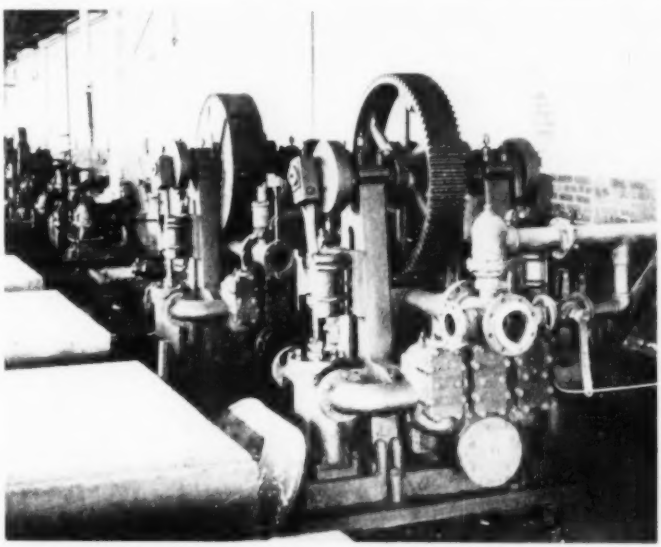
This plant survey produced an initial list of 26 items. A few weeks later, a progress report in the middle of July, 1951, indicated three of the largest items were almost completely scrapped and most of the remainder on a definite time schedule for early attention. A short time later, five more items were added to the Marcus Hook list. Another progress report from mid-December showed only one of the final 31 items still required handling.

Regular refinery personnel handled all the scrapping work. Supervised by a rigger foreman, three crews of four, eight, and ten men demolished buildings, cut the metal to under 2 x 2 x 6 ft. (to fit an open-hearth charging door). They used typical building wrecking equipment, swing-balls, cranes, dynamite, acetylene torches, trucks, grab-buckets. They separated salvage from scrap. Scrap was loaded directly into the dealers' trucks and weighed out of the refinery on the truck scales. Debris and rubble was sent to the fill-in operations. Ground was leveled and finished.

Improved operating efficiency was another important "plus" factor resulting from the drive," Mr. Barton emphasized. "Sometimes inefficient equipment can be operated with special effort," he explained. "It remains with you as a temptation to use. As long as it's around, there's the temptation to start it up again. And if you do start it up, there's the temptation to keep it going."

Top management alone can make the decisions on whether facilities should be scrapped while they still possess some usable life, Mr. Barton pointed out. No scrap campaign can be successful without full support of top management.

Sun's overall campaign included, in addition to Marcus Hook, a drive at the Toledo refinery and throughout the field production operations.



THESE PUMPS, and more like them, contributed another 64½ tons of salable scrap to the Sun drive

Union's Cobalt Molybdate Process For Refining High Sulfur Stocks

The cobalt molybdate process employs catalytic treatment in the presence of a recycle hydrogen stream for the production of premium fuels from high sulfur crudes as well as stocks derived from shale and oil sand. The high activity of the catalyst effects virtually complete elimination of sulfur, nitrogen and oxygen from the charge stock. It is generally preferable to prepare the charge stock by coking to adjust the boiling range. Under mild hydrogenation conditions full range coker distillate is converted into quality diesel fuel and jet fuel. Treatment of the light coker distillate under reforming conditions yields high octane gasoline.

The Hyperforming process is announced as eliminating fixed bed reactors and permitting continuous reaction and regeneration of the catalyst in upgrading and reforming. Circulation of the catalyst is by means of the Mass Flow solids moving principle recently developed by Union Oil Co. This paper was presented before the Oil Sands Project Conference in Edmonton, Alberta, Sept. 12, 1951.

By CLYDE BERG

Union Oil Co. of California

THE cobalt molybdate process employs as its fundamental reactions the conversion of organically combined sulfur, nitrogen and oxygen to hydrogen sulfide, ammonia, and water by contact of the feed stock with the catalyst in the presence of hydrogen. The catalyst has been developed over a number of years by the Union Oil Co. and exhibits excellent activity as well as heat stability and abrasion resistance.[1,2,3]

The desulfurization of low grade stocks in this process is associated with the consumption of hydrogen and an appreciable exothermic heat of reaction. Hydrogenation of the olefins in the stock occurs, but under the conditions normally used essentially none of the aromatics present are hydrogenated. When reforming conditions are utilized, substantial dehydrogenation of napthenes occurs, but under mild hydrogenation conditions this occurs only to a minor degree.

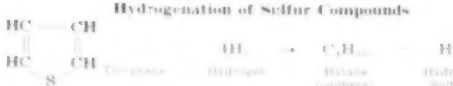
Conversion of the sulfur, nitrogen, and oxygen compounds to saturated hydrocarbons and inorganic by-products occurs by cleavage of the carbon-sulfur, carbon-nitrogen, and carbon-oxygen bonds. Essentially no carbon-to-carbon bonds are broken. As an illustration of the nature of the reactions occurring during cobalt molybdate refining, they are presented in Table 1 illustrated as the various classes of compounds undergoing conversion.

Processing Conditions

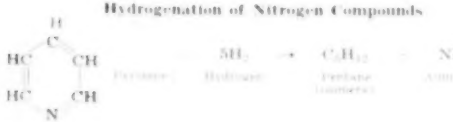
Processing conditions for the cobalt molybdate refining of low grade stocks have been worked out in extended pilot plant investigations.[4] A summary of processing conditions and product characteristics for the treatment of coker distillate from

Table 1—Reactions of Various Classes of Compounds in Cobalt Molybdate Refining

Hydrogenation of Sulfur Compounds



Hydrogenation of Nitrogen Compounds



Hydrogenation of Oxygen Compounds

Hydrogenation of Olefins

Table 2—Pilot Plant Processing Conditions and Product Inspection in Cobalt Molybdate Refining of Full Range Santa Maria Coker Distillate

Operating Conditions:	
Average Bed Temperature, °F	858
Reactor Pressure, psig	1000
Feed Rate, gal./hr./cu. ft.	3.01
Space Velocity, V/V/hr.	3.19
H_2 Content Recycle Gas, vol. %	90.9
Run Length, hrs.	126
Calculated Results:	
Liquid Product Yield:	
C_5 Plus, vol. % feed	102.7
Pentanes, vol. % feed	2.16
Butanes, vol. % feed	1.79
Dry Gas, C_1-C_3, SCF/bbl. feed	186.7
Net H_2 Consumption, SCF/bbl.	907
Material Balance, %	99.2
Product Analysis:	
Gravity, °API	39.0
Sulfur, wt. %	0.08
Nitrogen, wt. %	0.025
Distillation Yield, vol. %	
Jet Fuel	28.2
Diesel*	67.8
Residuum	3.9
Gasoline Analysis:	
Gravity, °API	57.1
Sulfur, wt. %	0.02
Nitrogen, wt. %	0.011
Knock Rating, M.M.	54.0
Diesel Analysis:	
Gravity, °API	33.1
Sulfur, wt. %	0.04
Nitrogen, wt. %	0.10
Cetane No.	41
Pour Point, °F.	-5
Residuum Analysis:	
Gravity, °API	25.1
Sulfur, wt. %	0.12
Nitrogen, wt. %	0.19

* This material represents maximum diesel within specification boiling range.

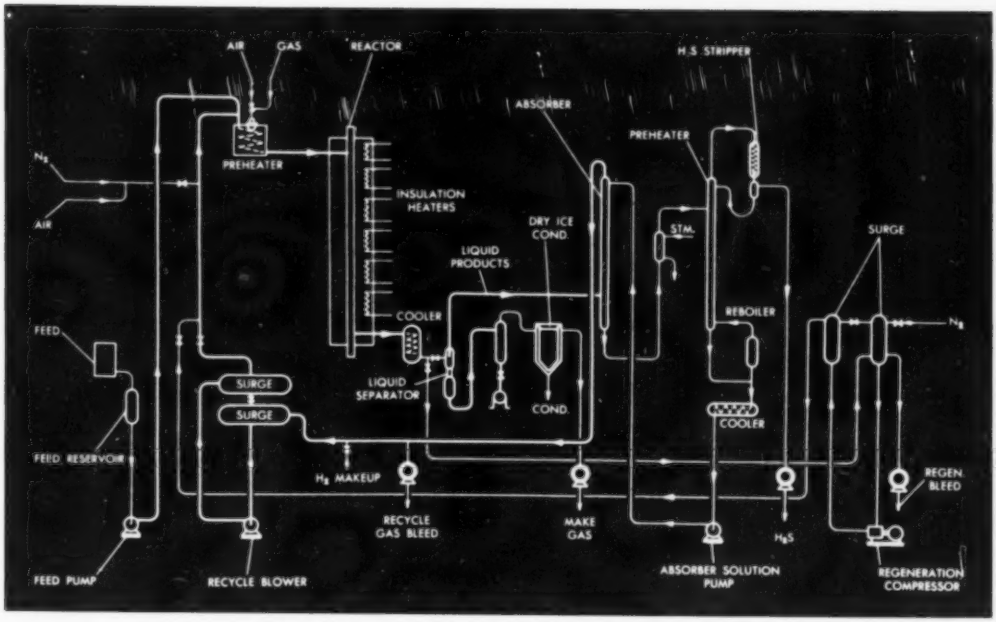


FIG. 1—Diagram of cobalt molybdate refining pilot plant

Santa Maria Valley crude is presented in Table 2.

These studies were carried out in the pilot plant illustrated in Fig. 1. This pilot plant was designed to develop as nearly as possible the process conditions and expected cycle to be used in commercial operations. The unit is equipped with an adiabatic reactor and accessory equipment so that the recycle hydrogen and scrubbing of this stream for removal of hydrogen sulfide and ammonia can be carried out.

The reactor corresponds with expected commercial design with respect to catalyst and lineal velocity of recycle hydrogen and naphtha vapors through the bed. Operation of reaction, regeneration, re-heat and purge were carried out to correspond as nearly as possible to the expected commercial cycle in regard to rate direction of flow, temperature, and duration.

Where motor fuel is desired as an end product from the light distillates of coking, reforming conditions are employed. By the utilization of higher temperatures and lower pressures in the refining step, dehydrogenation of the naphthenes occurs simultaneously with the various other upgrading reactions outlined in the previously described plant. A substantial amount of isomerization and hydrocracking also occurs, which appreciably contributed to the premium quality of the motor gasoline produced. Table 3 presents the inspections of motor gasoline produced from Santa Maria Valley light coker distillate by reforming.

Hydrogen consumption in the mild hydrogenation plants treating full range coker distillate is on the order of 750 to 1,000 cu. ft. bbl. whereas hydrogen consumption in Hyperforming plants reforming light coker distillate is on the order of 300 to 600 cu. ft. bbl.

Table 3—Inspection of Feed and Product in Pilot Plant Reforming of Santa Maria Light Coker Distillate

	Feed	Product
Gravity, °API	52.7	60.0
Engler Dist., °F		
Initial	147	87
10%	192	131
30%	267	205
50%	342	328
90%	384	415
Max.	394	429
Sulfur, wt. %	3.47	0.025
Nitrogen, wt. %	0.020	0.002
Octane Rating		
F-1 + 3 cc. TEL	80.0	84.5
F-2 + 3 cc. TEL	69.5	87.0

Commercial Applications

The cobalt molybdate desulfurization process is adaptable to a number of different programs for the utilization of low grade stocks containing sulfur, nitrogen, and oxygen. Typical stocks which require the highly effective refining of the cobalt molybdate process are Santa Maria Valley crude oil, shale oil, and oil from the Athabascan oil sands. Table 4 gives typical inspections of these crude oils. It will be noted that high sulfur and

Table 4—Low Grade Crude Oils Suitable for Refining by the Cobalt Molybdate Process

	Santa Maria Valley Crude	Shale Oil	Athabasca Tar Sand
Gravity, °API	15.2	20.7	5.6
Spec. Grav. at 60° F	0.965	0.930	1.032
Ash, wt. %		0.03	0.884
Sulfur, wt. %	1.50	0.77	5.12
Nitrogen, wt. %	0.84	2.01	
Carbon Residue, wt. %	10.14		
Visc. (Furol) at 210°			373 secs.
Visc. SSU at 100° F		227	
Visc. SSU at 210° F		48	
Softening Point, °F			85

Table 5—Low Grade Coker Distillate Suitable for Refining by the Cobalt Molybdate process

	Santa Maria Valley Crude	Shale Oil	Athabasca Tar Sand
Gravity, °API	27.6	32.6	16.6
Nitrogen, wt. %	0.27	1.47	
Sulfur, wt. %	3.77	0.74	4.04
Eng. Dist., °F			
Initial	160	172	445
10%	340	337	486
30%	438	440	550
50%	500	524	621
70%	600	582	690
90%	816	654	715
Max.	907	713	
Rec.	99.0	98.0	82.5

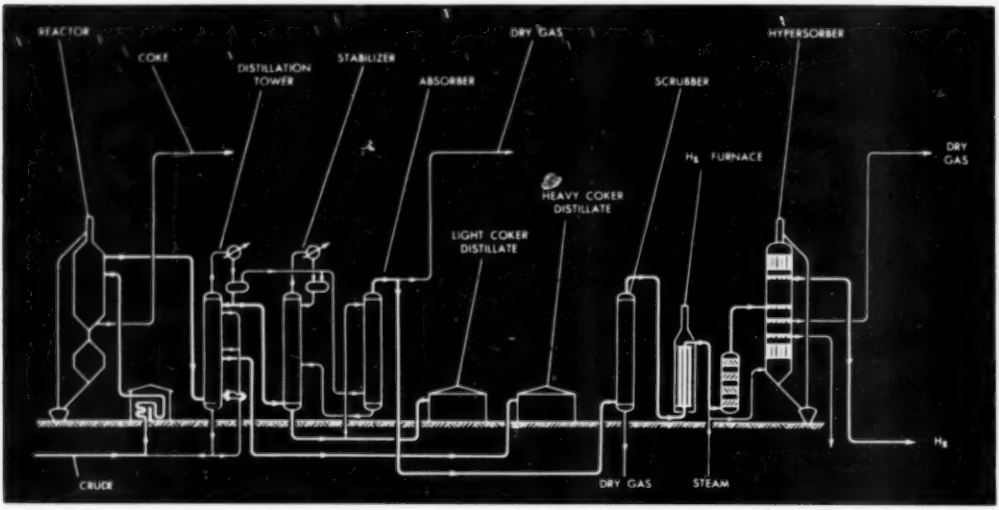


FIG. 2—Flow sheet of coking operation and hydrogen production

nitrogen compounds are typical of all these stocks.

As the first step in refining, it is generally desirable to carry out thermal coking to adjust the boiling range of these stocks to that of commercially marketable premium fuel. The products of coking then actually become the charge stocks to the cobalt molybdate refining process. In Table 5 is given the inspections of coker distillates derived from the respective crudes listed above.

It will be noted that only minor reductions of sulfur, nitrogen, and oxygen occur in coking although an appreciable change in boiling range is effected. In the course of coking a substantial amount of gas is generated, and this gas stream is utilized for the production of hydrogen by steam-methane reforming. A flow sheet detailing the continuous contact coking operation with subsequent steam-methane reforming is given in Fig. 2.

Before entering the catalyst-containing reactor of the cobalt molybdate reforming plant, the coker distillate and recycle hydrogen are preheated by heat exchange in separate exchangers against the hot reaction products. Fig. 3 outlines the details of this mild hydrogenation plant. The exothermic heat of reaction obtained by the coker distillates is of sufficient magnitude to make the process independent of appreciable pre-heat requirements except during start-up periods. The recycle gas is purified of hydrogen sulfide and ammonia by absorption at reaction pressure. Regeneration is accomplished by adding air to a stream of inert combustion gas which is circulated over the catalyst by means of a blower.

Where motor fuel is desired as an end product from the light distillates

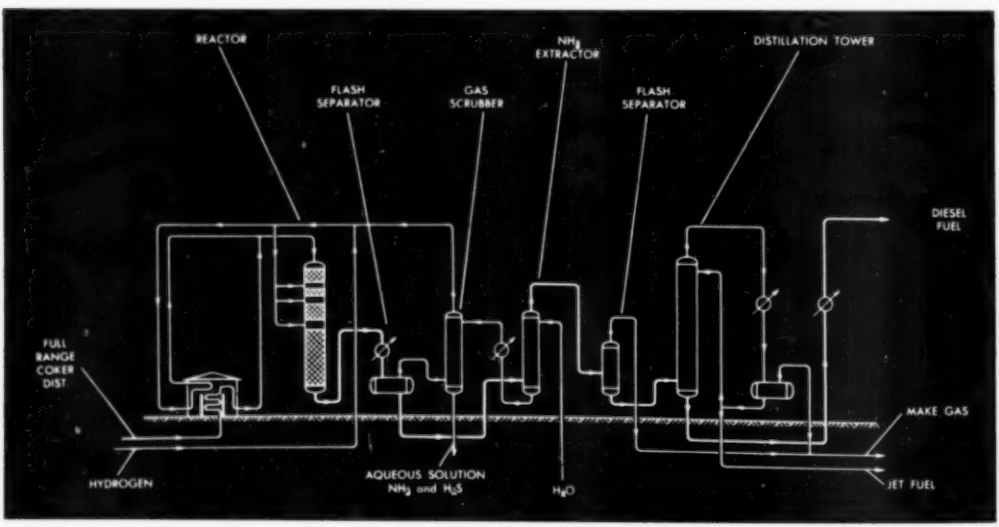


FIG. 3—Flow sheet of cobalt molybdate refining plant (mild hydrogenation)

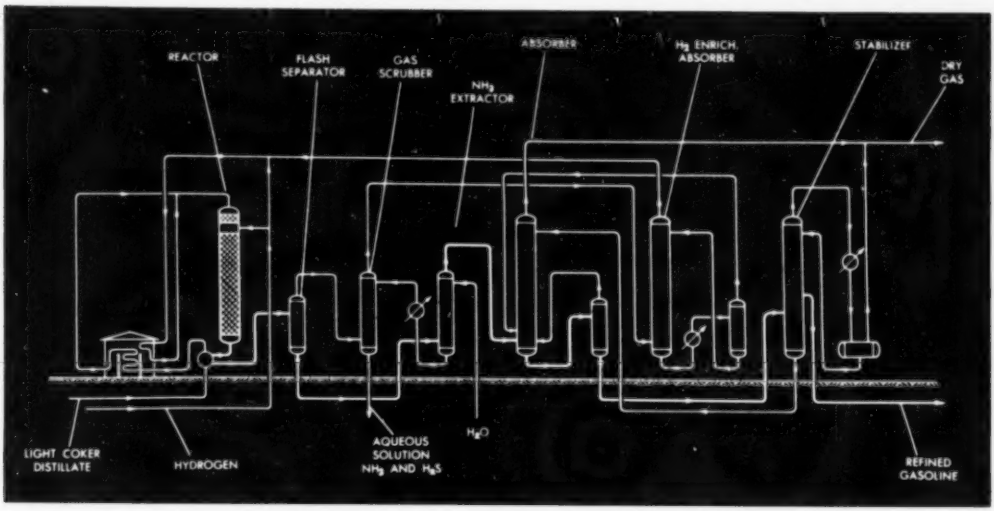


FIG. 4—Flow sheet of cobalt molybdate reforming plant

of coking, an additional modified cobalt molybdate reforming plant is employed. A diagram of this plant is presented in Fig. 4. The principal difference in operating characteristics of the reforming plant is utilization of higher temperatures and a lower pressure in the refining step.

Cobalt Molybdate Refining Products

The combination of coking and cobalt molybdate refining leads to very high yields of directly commercially marketable products. The refined products derived from Santa Maria Valley crude and crude oil from Athabascan oil sands would be rather similar and it will be noted that both the crude and the coker distillates have comparable inspections as to sulfur contents. Table 6 presents the yield and quality of products derived from refinery operations on 100,000 bbls. of Santa Maria Valley crude oil. It will be noted that a yield of approximately 82% of high grade fuels is obtained and that the nitrogen and sulfur are almost completely eliminated from the refined products.

A very similar sequence of refining steps is carried out on shale oil, and a table of yield and quality products derived from these operations on 100,000 bbls. of shale oil is presented in Table 7.

The high yield and quality of products obtained from the refining operation establishes the cobalt molybdate refining process as one of major importance in the upgrading of these low grade stocks.

Hyperforming

An important advance in the facilities available for catalytic upgrading and reforming has recently been achieved by the development of the Hyperforming process. This process eliminates the use of fixed bed reactors and permits continuous reaction and regeneration of the catalyst. An assembly diagram of a Hyperforming plant is given in Fig. 5. Circulation of the catalyst is effected by means of the mass flow solids moving principle recently developed by the Union Oil Co., which moves catalyst at very low velocities and at a minimum attrition loss. By the use of continuous reaction and regeneration in the catalyst cycle, a substantial economy in plant construction is effected and plant maintenance is substantially reduced.

The reductions in over-all plant investment and utility requirements effected by this most recent advancement in refining technique, the Hyperforming process, are a distinct contribution to the technology of the upgrading of low grade stocks and a variety of refinery products.

Acknowledgement

The author wishes to express his appreciation to the Union Oil Co. of California for permission to publish this review of the refining of high sulfur stocks by the cobalt molybdate process.

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Table 6—Products from Thermal Coking and Cobalt Molybdate Hydrogenation of 100,000 Bbls. of Santa Maria Crude Oil

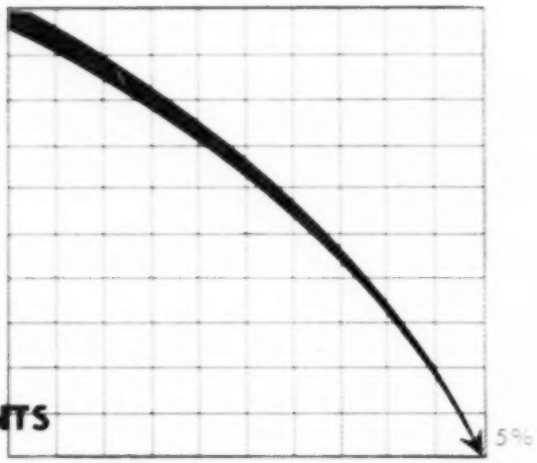
Gas, MSCF	22,710
Jet Fuel, bbls.	23,300
Diesel Fuel, bbls.	36,500
Residuum, bbls.	3,250
Coke, tons	2,570
Ammonia, tons	57

Product Data	Jet Fuel	Diesel Fuel
Gravity, °API	57.1	39.1
Freezing Point, °F.	-75	
Bromine Number	0.4	
Sulfur, wt. %	0.02	0.04
Nitrogen Content, wt. %	0.011	0.10
Cetane Number		44
Pour Point, °F.		-5

Table 7—Products from Thermal Coking and Catalytic Hydrogenation of 100,000 Bbls. of Crude Shale Oil

Gas, MSCF	51,000
Jet Fuel, bbls.	51,500
Diesel Fuel, bbls.	33,500
Coke, tons	2,580
Ammonia, tons	260

Product Data	Jet Fuel	Diesel Fuel
Gravity, °API	51	32
Freezing Point, °F.	-76	
Bromine Number	0.5	
Sulfur Content, wt. %	0.10	0.02
Nitrogen Content	0.01	
Cetane Number		55
Pour Point, °F.		-25
Visc., SSU at 100° F.		35



HOW SIX PLANTS

Cut Corrosion Rates By 95%

By WILLIAM C. UHL
Equipment Editor

PETROLEUM processing's Enemy No. 1—corrosion—is now being whipped thoroughly in a number of refineries and natural gasoline plants using a new type inhibitor. A survey by PETROLEUM PROCESSING magazine of six different plants where the material has been in use for a year or more shows it has reduced corrosion rates an average of 95%, with one user claiming 100% reduction and the lowest being 85%.

Designed to fight most of the corrosive agents in petroleum hydrocarbons at temperatures not over 450 F, the material is an organic chemical compound which deposits a thin, lasting protective film over metal surfaces in equipment exposed to oils and vapors. The survey indicated it is being used in the following types of corrosion problems:

1. The feed stream to a debutanizer, where it exchanges heat with the debutanized gasoline stream.
2. Overhead vapor lines and condensers on a topping unit.
3. Straightrun gasoline lines in a light ends unit.
4. Coolers, separators, and lines in a gasoline plant compression system.
5. Condensers and reflux accumulators in a crude flash tower overhead system.
6. Condensers, accumulators, and rundown tanks in a gasoline recovery plant in a refinery.
7. Steam stripper trays and walls.

In addition the compound is undergoing test programs by several other oil companies in such equipment as depropanizers, demethanizers, sulfur recovery units, and the like.

Exact costs are not readily available. The amounts of inhibitor which must be injected into each specific system depends entirely on the type and the severity of corrosion being encountered. A general average of those installations reported to PETROLEUM PROCESSING runs in the range of 2 to 5 lb /1000 bbl. throughput. However, this quantity may be too much in one case or not enough in another.

Cost per bbl. of plant throughput can be estimated at about 0.9 mills. This is calculated on the basis of using about 3 lbs /1000 bbl., or 10 ppm. A gallon of the inhibitor weighs approximately 8 lbs. and costs $2.00 (in 55-gal. drums f.o.b. the manufacturer). Price is somewhat lower in multiple drum orders.

Methods of introducing the material into the system to be treated vary also. Injection equipment can be quite simple or rather elaborate. Some plants use a one-shot daily injection. Others inject intermittently or continuously with a proportioning pump.

How Does the Inhibitor Work?

The relatively high molecular weight, semi-polar inhibitors employed by the six petroleum plants reported here are believed to function by their adsorption on metal surfaces to form well-organized films, one molecule in thickness.

Whether such films are preferentially adsorbed at particular spots on the metal surface—such as at local anodes or cathodes of the corrosion cell—has not been clearly established. Also, the nature of the forces responsible for adsorption are not clearly determined. These forces may be those involved in a direct chemical bond between the metal and the inhibitor, or they may be weaker di-polar forces such as are often characterized as Van der Waal's forces.

The results of the investigations of various workers in this field, employing electron diffraction and other methods of study of films of adsorbed inhibitors on steel surfaces, have indicated that at least some high molecular weight, semi-polar inhibitors undergo a general adsorption on metal surfaces to form films with considerable orientation and structure, and further, that the adsorption is not completely or rapidly reversible.

It is this surface adsorption which inactivates a portion of the metal surface and imposes a barrier to migration of the corrosive medium to the metal surface. Further experimentation and application of inhibitors of this kind will be required to define clearly their limits of use and the detailed kinetics of their action.

C. M. BLAIR,
Director of Research
The Tretolite Co.

Results in most reported cases have been measured in terms of the iron content of the fluid coming from the corrosive zones in equipment being treated. Expressed as parts per million (ppm) of iron, typical reductions in corrosion rates have been 28 to 0, 61.9 to 1.8, 10 to 1, 34 to 1, and 10 to 1, 160 to 4.5. In some installations it has been necessary to employ a combination injection procedure of both the inhibitor and ammonia.

Developed and manufactured by the Tretolite Co., the inhibitor is tradenamed "Kontol" and is being formulated in various types for specific applications. As described by Dr. C. M. Blair, director of research, and Dr. William F. Gross, research dept., Tretolite, the material belongs to a class of inhibitors known as "semipolar organic corrosion preventatives."

Corrosion stopped entirely—debutanizer exchanger

The application of the inhibitor to a corrosion problem in the debutanizer feed stream heat exchanger occurred at the Robinson, Ill., refinery of the Ohio Oil Co. Feed comes from a straight absorber and enters the debutanizer at 200 psi. and about 230° F., such conditions allowing the presence of liquid water. (See diagram, Fig. 1.) Throughput amounted to 5000 b/d gasoline and 1 b/d water. The water contained 500 ppm. chlorides at pH 8.8, and considerable quantities of H_2S, the latter consequently present in the form of polysulfide salts. Finely divided black iron sulfide was also present in considerable quantities.

The exchanger consists of a single bundle of common steel tubes, which underwent severe corrosion from the tube side out. It appeared to be caused by H_2S in the presence of brine. On the original run, the tubes went out in about three months. Ohio Oil then re-tubed about 50% (the top half) of the tubes, using common steel again. The exchanger tubes then lasted about six weeks, and the top half was re-tubed once more.

That was done November 20, 1949. Life expectancy should have terminated around January 1, 1950. However, about four weeks after the re-tubing on December 14, 1949, a Kontol injection program was established. As shown in Fig. 1, injection is into the feedstream line, approximately three ft. ahead of the exchanger. A water trap was installed about 20 ft. beyond the exchanger. The iron contents of water collected in this trap provided a means for determining corrosion rates in the exchanger.

Removes Iron Sulfides

Table 1 shows a daily record of results. Inhibitor injection for the first three days was maintained relatively high for experimental purposes. It was reduced after careful check on the iron contents. Before injection, water samples had been black with finely divided iron sulfide. Three days after treatment started, the water cleared up completely.

In July, 1950, injection rates were further reduced to the present rate of 1 gal./day. Treatment has continued without interruption. The bundle was still in good condition in July, 1951, 20 months after it had been put into operation.

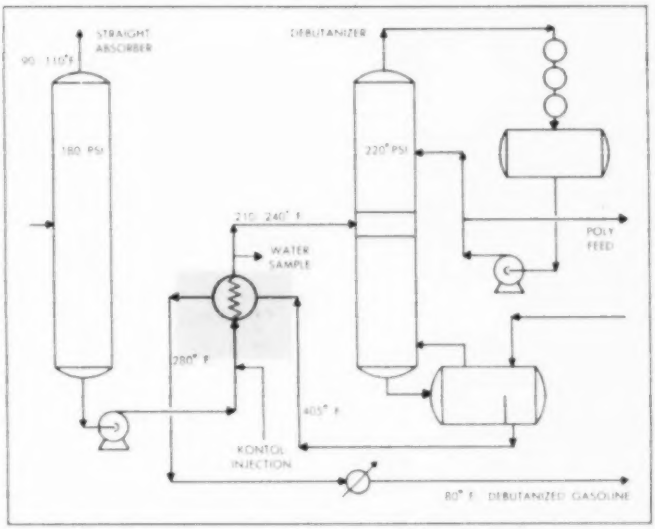


FIG. 1—Flow diagram of Fluid catalytic cracking unit debutanizer (Colored area shows location of corrosion)

On start-ups of the unit after shutdowns, it has been found expedient to boost the injection rate a bit for the first three or four days and then return it to 1 gal./day. In the beginning, a chemical injection pump had been used for injection, but the quantity was so small it was difficult to handle in such a proportioning pump. Since May, 1950, the plant has changed over to one-shot (batching) methods, eliminating the pump.

It was pointed out that the feedstream to the debutanizer comes from a straight absorber, and not a de-ethanizer absorber which might possibly have gotten rid of much of the H_2S and other corrosives.

Table 1—Corrosion Reduction in Debutanizer Heat Exchanger

Date	Inhibitor gals./day	Iron content ppm.	Date	Inhibitor gals./day	Iron content ppm.
12/1/49		21.00	12/20/49	7.2	2.18
12/2/49		7.19	12/30/49	5.0	2.18
12/5/49		12.38	12/31/49	4.0	0.00
12/6/49		12.40	1/1/50	3.5	
12/7/49		17.60	1/2/50	4.0	2.18
12/8/49		26.50	1/3/50	3.8	
12/9/49		28.00	1/4/50	4.0	
12/10/49		14.00	1/5/50	4.0	
12/12/49		11.00	1/6/50	4.5	
12/12/49		11.00	1/7/50	4.0	
12/13/49		11.00	1/8/50	4.7	
12/14/49	22.1	17.00	1/9/50	4.4	
12/15/49	30.5	8.1	1/10/50	4.3	
12/16/49	20.4		1/11/50	4.5	
12/17/49	28.5	22.8	1/12/50		2.62
12/18/49	26.5	4.36	1/13/50		2.62
12/19/49	17.8	2.18	1/14/50	22.1	1.31
12/20/49	8.0		1/15/50	30.5	1.31
12/21/49			1/16/50	24.0	1.31
12/22/49			1/17/50	28.5	0.43 to 2.6
12/23/49	8.8		1/18/50	26.5	
12/24/49	13.0		1/19/50	17.5	
12/25/49	21.5	2.76	1/20/50	8.0	
12/26/49	10.0	2.76	30 June 50	2 to 3	
12/27/49	8.8	1.31	30 Aug.	1.5 to 2	
12/28/49	8.0		now 50#	1.0	

Inhibitor and ammonia combination most successful

Problems in a crude topping unit and in some gasoline streams were solved with the new organic inhibitor by Globe Oil & Refining Co., Lemont, Ill. As reported to PETROLEUM PROCESSING by Globe's chief chemist, Dr. William F. Krause:

"Ammonia injection in vapor lines has been the standard practice for many years to protect condenser and heat exchangers against hydrochloric acid and H_2S corrosion. Kontol was tried first in the topping unit vapor lines and condensers, and later was used in the light oil unit straightrun gasoline streams. After a successful period there, it was added to the cracked gasoline stream. When another cracking furnace was returned to service as cracking unit, the material was added to the gasoline stream.

"To determine the effectiveness of the treatment, the water condensate from the water separators after the condensers was sampled and analyzed for iron, copper, and zinc. Copper analysis is important because over-injection of ammonia dissolves the copper from admiralty condensers and causes serious damage. It was felt that if Kontol could replace ammonia, it would be highly desirable because of the difficulties with accurate control of ammonia at a pH not to exceed 7.2.

"Kontol is non-volatile, and is coated in a thin film on the interiors of pipes by its dispersion in the hydrocarbon stream. The interiors of the fractionators are protected by its dispersion in the reflux streams. Inspection has shown there is protection down to the kerosine section of the towers.

"The injection schedule has been as follows:

"1. First 7 days: 1 gal. Kontol per 1000 b/d gross stream (net production plus reflux). Ammonia left in.

"2. Next 7 days: 2/3 gal. 1000 bbl. gross stream daily. Ammonia left in.

"3. After 14 days: 0.2 gal. 1000 bbl. Ammonia discontinued.

"4. After several weeks of operation, it appeared that the results were not as good where the pH dropped below 3. To provide maximum protection ammonia is now added to hold the pH at 3.5 to 4.5. In this range the admiralty tubes are not damaged, yet the Kontol can build up a satisfactory surface coating.

"The laboratory analyses are shown in Tables 2, 3, and 4. Tests on the water condensates give good indications of the effectiveness of corrosion control, but the only reliable information comes from actual physical inspection of the unit.

Topping Unit Proper

"Tests on the topping unit gasoline (Table 2) indicate there has been definite improvement in the corrosion of the copper and zinc from the admiralty condensers. A small amount of ammonia gives a lower iron loss than when no ammonia is used. Apparently the organic inhibitor does not provide a satisfactory film at extremely low pH. Very little ammonia is needed to hold the pH between 3.5 and 4.5.

"Inspection after about 125 days on 100% sour crude using Kontol showed the topping unit to be very clean. In fact, the exchangers were as clean as when they were put in service at the start of the run. There was no significant metal loss on vapor lines or condensers, which had not been the case previously without Kontol. There was film protection on the crude fractionator down to the kerosine section.

Light Oil Unit

"The straightrun gasoline streams have all shown improvement. Iron, copper, and zinc losses are lower with Kontol than with only ammonia. (See Table 3). The pH does not go as low as the topping unit, except on one stream. Ammonia is now used as required to keep pH to 3.5-4.5.

"The unit was inspected after about 125 days of operation and results were quite satisfactory. It was not as clean as the topping unit but was cleaner than previous inspections before the use of Kontol."

Globe had the same problem in connection with shutdowns that Ohio Oil had. It was found that the protective film apparently was destroyed during a shutdown, as indicated by increased iron losses immediately after start-ups following inspections. As a result, it has been advisable to increase the dosage the first few days a unit returns onstream.

Corrosion is being controlled satisfactorily on cracked gasoline streams also, though not as spectacularly because the severity of the corrosion was not as great. (See Table 4).

Kontol acts as a detergent at the same time it lays down a film, doing a thorough job of removing old scale and rust. At Globe's heavy oil unit, a cracking furnace was put back into operation after having been idle for several months. Iron losses were extremely high for the first 30 days (during which time Kontol was injected), running up to 621.7 ppm. They have decreased to around 1.8 ppm, and it is believed the unit will be in good shape at inspection time.

Table 2—Analysis of Aqueous Condensates from Topping Unit Gasoline Stream

Composite Sample Dates	Iron ppm	Copper ppm	Zinc ppm	pH	Type of Treatment
5-28—5-30-51	1.40	1.06	0.040	7.6	Ammonia
5-30—6-2-51	0.60	0.42	0.140	7.6	Ammonia
6-3—6-5-51	0.80	0.42	0.120	7.4	Ammonia
6-5—6-9-51	1.60	0.55	0.160	8.6	Ammonia
6-9—6-11-51	0.23	0.23	0.120	7.4	Ammonia
6-11—6-13-51	0.56	0.36	0.120	7.4	Ammonia
6-13—6-15-51	0.60	0.36	0.068	7.5	Ammonia
6-15—6-18-51	0.56	0.36	0.100	7.4	Ammonia
6-18—6-20-51	0.60	0.36	0.084	7.4	Ammonia
6-20-51	1.00	1.10	0.074	7.4	Ammonia
6-22-51	1.28	0.16	0.216	7.2	Ammonia
6-25—6-26-51	0.20	0.06	0.020	7.0	Ammonia & Kontol
6-26—6-27-51	0.40	0.06	0.064	7.2	Ammonia & Kontol
6-27—6-28-51	0.44	0.10	0.100	7.4	Ammonia & Kontol
6-28—6-30-51	0.24	0.10	0.064	7.5	Ammonia & Kontol
6-30—7-2-51	0.24	0.10	0.060	7.6	Ammonia & Kontol
7-2—7-4-51	0.24	0.10	0.060	7.5	Ammonia & Kontol
7-4—7-6-51	0.28	0.16	0.060	7.2	Ammonia & Kontol
7-6—7-11-51	0.28	0.16	0.060	7.5	Ammonia & Kontol
7-11-51	0.28	0.02	0.120	7.5	Ammonia & Kontol
Average	0.53	0.24	0.090	7.2	Ammonia & Kontol
4-12-51	1.00	0.50	0.060	2.6	Kontol
4-13-51	1.00	0.50	0.110	2.8	Kontol
4-16—4-17-51	1.00	0.45	0.074	3.2	Kontol
4-17—4-19-51	1.00	0.50	0.048	2.8	Kontol
4-19—4-20-51	1.04	0.45	0.060	3.4	Kontol
4-23—4-24-51	1.00	0.30	0.062	3.8	Kontol
4-24—4-26-51	1.12	0.36	0.078	3.4	Kontol
4-26—4-27-51	0.60	0.36	0.026	4.0	Kontol
4-30—5-1-51	0.64	0.36	0.093	3.2	Kontol
5-1—5-3-51	5.83	0.32	0.092	3.5	Kontol
5-3—5-4-51	2.04	0.16	0.026	3.6	Kontol
5-7—5-8-51	2.44	0.16	0.084	3.5	Kontol
5-8—5-10-51	2.77	0.32	0.026	3.0	Kontol
5-10—5-11-51	2.64	0.32	0.042	3.0	Kontol
5-14—5-18-51	1.84	0.32	0.084	3.0	Kontol
5-21—5-25-51	2.87	0.16	0.095	3.2	Kontol
Average	3.13	0.28	0.125	3.2	Kontol
5-28—6-1-51	3.21	0.16	0.095	3.1	Kontol
6-4—6-8-51	1.97	0.32	0.069	2.9	Kontol
6-11—6-13-51	2.31	0.32	0.112	3.1	Kontol
6-14—6-22-51	0.26	0.16	0.060	6.0	Kontol
6-24—6-29-51	0.73	0.16	0.066	5.3	Kontol
Average	2.78	0.26	0.116	5.3	Kontol
7-2—7-6-51	1.16	0.32	0.073	5.5	Kontol & Ammonia
7-9—7-13-51	1.45	0.32	0.084	3.6	Kontol & Ammonia
7-16—7-20-51	1.53	0.32	0.116	2.7	Kontol & Ammonia
7-30—8-1-51	2.13	0.16	0.071	3.6	Kontol & Ammonia
8-6—8-10-51	1.97	0.16	0.092	3.2	Kontol & Ammonia
8-14—8-17-51	0.77	0.16	0.084	4.7	Kontol & Ammonia
8-20—8-24-51	0.92	0.16	0.087	3.2	Kontol & Ammonia
8-27—8-31-51	1.32	0.32	0.071	5.0	Kontol & Ammonia
9-4—9-7-51	1.06	0.32	0.073	5.2	Kontol & Ammonia
9-10—9-14-51	1.32	0.32	0.042	6.3	Kontol & Ammonia
Average	1.32	0.28	0.075	3.8	Kontol & Ammonia
9-17—9-21-51	2.31	0.32	0.066	5.6	Kontol & Ammonia
9-24—9-28-51	2.66			4.4	Kontol & Ammonia
10-1—10-5-51	1.40			7.2	Kontol & Ammonia

Table 3—Analysis of Aqueous Condensates from Light Oil Unit Straight Run Gasolines

Composite Sample Dates	Iron ppm	Copper ppm	Zinc ppm	pH	Type of Treatment	Iron ppm	Copper ppm	Zinc ppm	pH	Type of Treatment	Iron ppm	Copper ppm	Zinc ppm	pH	Type of Treatment
3-26—3-27-51	0.8	0.19	0.047	7.4	Ammonia	0.96	0.40	0.053	7.2	Ammonia	66.7	2.40	0.096	6.9	Ammonia
3-27—3-28-51	0.4	0.20	0.012	8.0	Ammonia	0.96	0.66	0.064	7.1	Ammonia	68.7	1.80	0.090	7.1	Ammonia
3-29—3-30-51	1.30	0.80	0.040	8.0	Ammonia	1.56	0.60	0.050	8.0	Ammonia	98.0	0.60	0.224	8.3	Ammonia
4-2—4-3-51	0.42	0.25	0.070	8.0	Ammonia	1.30	0.46	0.190	8.6	Ammonia	11.6	2.34	0.180	8.3	Ammonia
4-3—4-4-51	0.22	0.25	0.067	8.2	Ammonia	0.22	0.20	0.042	7.9	Ammonia	2.7	1.67	0.197	8.1	Ammonia
4-5—4-6-51	0.42	0.25	0.901	7.2	Ammonia	1.20	0.80	0.124	8.2	Ammonia	7.8	0.45	0.200	8.3	Ammonia
4-17—4-18-51	0.92	0.60	0.124	8.3	Ammonia	12.00	1.68	0.190	8.9	Ammonia	15.4	0.80	0.190	8.6	Ammonia
Average	1.01	0.21	0.082	7.7	Ammonia	2.05	0.44	0.086	7.8	Ammonia	28.8	1.30	0.182	8.2	Ammonia
4-19—4-20-51	0.24	0.16	0.067	7.5	Ammonia	0.60	0.67	0.070	8.2	Ammonia	0.42	0.50	0.124	7.8	Ammonia
4-23—4-24-51	0.24	0.16	0.066	8.1	&	1.10	0.42	0.045	7.6	&	2.72	0.46	0.110	8.4	&
4-24—4-25-51	0.18	0.16	0.050	8.2	Kontol	3.98	0.80	0.158	8.8	Kontol	3.84	0.38	0.099	7.8	Kontol
4-26—4-27-51	0.18	0.16	0.051	8.6		0.54	0.32	0.166	8.2		0.90	0.30	0.066	8.1	
4-30—5-1-51	0.18	0.16	0.042	8.1		1.60	0.48	0.158	8.1		0.54	0.46	0.087	7.6	
5-1—5-2-51	0.18	0.16	0.050	8.0		0.42	0.32	0.174	8.0		1.20	0.36	0.092	7.8	
Average	0.20	0.16	0.063	7.8		1.91	0.49	0.114	8.0		2.30	0.21	0.095	7.9	
5-2—5-3-51	0.24	0.00	0.042	8.8	Kontol	1.84	0.32	0.064	8.1	Kontol	1.84	0.48	0.100	8.3	Kontol
5-7—5-8-51	0.24	0.20	0.046	8.4	Ones	1.47	0.32	0.186	8.6	Ones	1.84	0.32	0.092	8.4	Ones
5-8—5-10-51	0.02	0.32	0.042	8.6		1.45	0.48	0.068	8.8		0.92	0.16	0.050	8.4	
5-10—5-11-51	0.28	0.16	0.055	8.2		1.35	0.32	0.091	8.4		1.72	0.32	0.090	8.6	
5-14—5-15-51	0.20	0.16	0.052	8.2		0.78	0.64	0.102	7.4		0.38	0.32	0.080	7.9	
5-21—5-22-51	0.36	0.16	0.052	8.4		0.93	0.16	0.066	8.3		0.77	0.32	0.084	8.0	
Average	0.41	0.16	0.057	8.7		1.24	0.37	0.080	8.2		2.33	0.32	0.096	8.2	
5-28—6-1-51	0.48	0.32	0.102	8.5	Kontol	0.84	0.32	0.102	8.6	Kontol	3.58	0.48	0.100	8.4	Kontol
6-4—6-5-51	0.72	0.16	0.066	8.6	Kontol	1.84	0.16	0.094	8.8	Kontol	1.84	0.32	0.118	8.8	&
6-11—6-12-51	0.96	0.32	0.078	8.2	Kontol	0.74	0.32	0.066	8.6	Kontol	10.58	0.48	0.140	8.6	Ammonia
6-15—6-22-51	0.58	0.16	0.044	8.0	Kontol	4.21	0.32	0.066	7.2	Kontol	0.92	0.32	0.078	7.8	
6-25—6-26-51	0.68	0.16	0.132	8.0	Kontol	1.00	0.16	0.132	8.5	Kontol	1.20	0.32		7.5	
Average	0.74	0.22	0.071	8.5	Kontol	2.75	0.28	0.092	8.6	Kontol	3.52	0.35	0.106	8.0	Ammonia
7-2—7-9-51	0.58	0.16	0.065	8.0	Kontol	1.16	0.16	0.052	8.6	Kontol	1.33	0.16	0.094	8.8	Kontol
7-9—7-13-51	0.57	0.16	0.048	8.4	Kontol	1.35	0.32	0.068	8.6	Kontol	1.21	0.16	0.066	8.6	&
7-16—7-20-51	0.26	0.32	0.068	8.7	Kontol	1.97	0.94	0.078	8.9	Kontol	1.84	0.48	0.084	8.6	Ammonia
7-23—7-27-51	0.08	0.16	0.102	8.8	Kontol	1.79	0.48	0.093	8.4	Kontol	2.76	0.32	0.052	8.4	
7-30—8-3-51	0.08	0.16	0.102	8.3	Kontol	0.47	0.32	0.062	8.9	Kontol	2.76	0.32	0.042	8.9	
Average	0.76	0.19	0.043	8.2	Kontol	1.56	0.38	0.065	8.8	Kontol	2.56	0.26	0.074	8.7	
Unit Shut down 8-6— 8-14-51															
8-15—8-24-51	0.28	0.32	0.066	8.2	Kontol	67.68	12.95	0.150	8.4	Kontol	13.81	0.48	0.125	7.8	Kontol
8-27—8-31-51	1.62	0.48	0.075	8.3	Kontol			No Water			9.24	0.32	0.081	7.8	&
9—9-7-51	2.42	0.48	0.096	8.4	Kontol			No Water			7.68	1.60	0.096	8.7	Ammonia
9-10—9-14-51	2.27	0.16	0.052	8.4	Kontol	0.84	0.048	0.064		Kontol	5.04	0.32	0.092	8.7	
Average	1.92	0.32	0.084	8.3	Kontol	37.3	6.32	0.115	8.4	Kontol	12.00	0.68	0.103	8.0	
9-17—9-21-51	2.00	0.16	0.034	8.6	Kontol	10.32	2.20	0.600	8.7	Kontol	2.94	0.32	0.102	8.2	Kontol
9-24—9-28-51	1.04			8.8				No Water			1.26			8.5	&
10-1—10-5-51	1.04			8.8							3.40			8.4	Ammonia

Table 4—Analysis of Aqueous Condensates from Light Oil Unit Cracked Gasoline Stream

Composite Sample Dates	Iron ppm	Copper ppm	Zinc ppm	pH	Type of Treatment	Composite Sample Dates	Iron ppm	Copper ppm	Zinc ppm	pH	Type of Treatment
3-26—3-27-51	0.60	0.40	0.186	6.9	Ammonia	7-2—7-5-51	0.20	0.16	0.033	7.7	Kontol only
3-27—3-28-51	0.40	0.43	0.010	7.7	Ammonia	7-5—7-6-51	0.42	0.16	0.033	7.5	Kontol only
3-29—3-30-51	0.42	0.08	0.096	7.9	Ammonia	7-9—7-10-51	0.18	0.16	0.033	7.9	Kontol only
4-2—4-3-51	0.22	0.00	0.100	7.8	Ammonia	7-10—7-11-51	0.21	0.16	0.052	7.9	Kontol only
4-3—4-4-51	0.22	0.15	0.020	8.4	Ammonia	7-12—7-13-51	0.19	0.16	0.026	8.1	Kontol only
4-5—4-6-51	0.42	0.15	0.067	7.9	Ammonia	Average	0.35	0.23	0.034	7.9	Kontol only
4-17—4-18-51	0.56	0.15	0.060	8.1	Ammonia	7-16—7-17-51	0.19	0.16	0.033	7.9	Kontol only
4-19—4-20-51	0.18	0.16	0.100	7.9	Ammonia	7-17—7-19-51	0.19	0.16	0.033	7.9	Kontol only
4-23—4-24-51	0.27	0.16	0.063	8.0	Ammonia	7-19—7-20-51	0.19	1.28	0.052	7.9	Kontol only
4-24—4-26-51	0.18	0.16	0.026	8.1	Ammonia	7-23—7-24-51	0.19	0.32	0.044	7.9	Kontol only
4-26—4-27-51	0.32	0.16	0.026	8.3	Ammonia	7-24—7-26-51	0.36	0.48	0.052	7.7	Kontol only
4-30—5-1-51	0.18	0.16	0.033	7.9	Ammonia	7-26—7-27-51	0.19	0.32	0.029	8.1	Kontol only
5-1—5-2-51	0.18	0.16	0.039	7.7	Ammonia	Average	0.22	0.37	0.040	7.9	Kontol only
Average	0.35	0.20	0.053	7.9	Ammonia	7-30—7-31-51	0.24	0.32	0.052	8.0	Kontol only
5-2—5-3-51	0.18	0.00	0.062	8.1	Ammonia	7-31—8-2-51	0.38	0.16	0.033	7.9	Kontol only
5-7—5-8-51	0.18	0.00	0.026	8.0	&	8-2—8-3-51	0.18	0.48	0.029	8.0	Kontol only
5-8—5-10-51	0.26	0.16	0.028	7.6	Kontol	Unit shut down—clean out 8-6-51 to 8-14-51					
5-10—5-11-51	0.26	0.48	0.021	7.9		Average	0.31	0.32	0.038	8.0	Kontol only
5-14—5-15-51	0.04	0.16	0.052	7.8		8-15—8-17-51	4.82	0.48	0.052	7.5	Kontol only
5-15—5-17-51	1.05	0.32	0.055	8.1		8-20—8-21-51	0.90	0.48	0.042	7.9	Kontol only
Average	1.92	0.24	0.035	7.9		8-21—8-23-51	0.72	0.32	0.052	7.9	Kontol only
5-17—5-18-51	0.26	0.16	0.040	8.0	Kontol only	8-23—8-24-51	0.54	0.32	0.052	7.9	Kontol only
5-24—5-25-51	0.18	0.16	0.042	8.2	Kontol only	8-24—8-27-51	0.54	0.32	0.052	7.8	Kontol only
5-28—5-29-51	0.36	0.16	0.068	8.2	Kontol only	8-27—8-28-51	1.29	0.32	0.068	7.9	Kontol only
5-31—6-1-51	0.18	0.16	0.044	8.2	Kontol only	8-28—8-30-51	0.78	0.32	0.058	7.8	Kontol only
6-4—6-5-51	0.36	0.16	0.042	8.2	Kontol only	Average	1.30	0.37	0.046	7.8	Kontol only
6-7—6-7-51	0.18	0.16	0.039	8.0	Kontol only	8-30—8-31-51	2.58	0.48	0.066	7.9	Kontol only
6-8—6-8-51	0.72	0.16	0.052	8.6	Kontol only	9-4—9-7-51	4.98	0.16	0.081	7.8	Kontol only
6-11—6-12-51	1.08	0.32	0.084	8.2	Kontol only	9-10—9-11-51	0.81	0.16	0.042	7.9	Kontol only
Average	0.47	0.18	0.050	8.2	Kontol only	9-11—9-13-51	0.81	0.16	0.042	7.9	Kontol only
6-12—6-14-51	0.72	0.16	0.052	8.3	Kontol only	9-14—9-14-51	1.47	0.64	0.042	8.3	Kontol only
6-14—6-15-51	0.36	0.16	0.052	7.2	Kontol only	9-17—9-18-51	0.81	0.16	0.052	7.4	Kontol only
6-18—6-20-51	0.36	0.16	0.044	7.6	Kontol only	Average	1.76	0.27	0.054	7.5	Kontol only
6-21—6-22-51	0.18	0.16	0.052	7.7	Kontol only	9-18—9-20-51	0.70	0.16	0.034	7.8	Kontol only
6-25—6-26-51	0.18	0.16	0.052	7.7	Kontol only	9-20—9-21-51	0.90	0.16	0.034	7.7	Kontol only
6-26—6-27-51	0.36	0.16	0.044	7.4	Kontol only	9-24—9-25-51	0.36			7.6	Kontol only
Average	0.36	0.16	0.048	7.7	Kontol only	9-25—9-28-51	0.44			7.9	Kontol only
6-28—6-29-51	0.29	0.32	0.004		Kontol only	10-1—10-3-51	0.08			7.8	Kontol only
						10-3—10-5-51	0.41			7.8	Kontol only

Gasoline recovery unit corrosion down over 99%

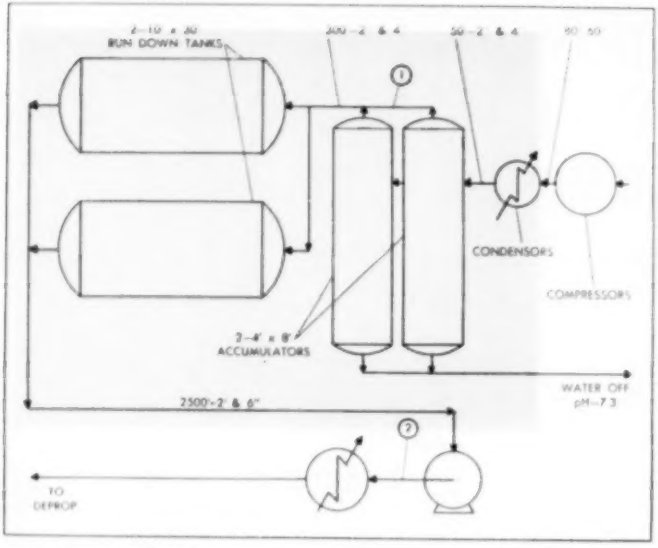


FIG. 2—Gasoline recovery unit. A Numerals indicate test stations.

In an Oklahoma refinery, gasoline is being recovered from vapors collected from stills, all product storage tanks, refinery processes, and tank farm crude oil storage tanks. This gas contains about 2 gals. of gasoline per MCF, some water and some H_2S. Gasoline recovered ranges from 100 to 800 b/d, depending upon operating conditions.

Table 5—Corrosion Reduction in Gasoline Recovery Plant

Run No.	Test Period in 1950	Inhibitor — Gal.	Inhibitor — Gal./1000 bbl.	Inhibitor — Gal./day	Gasol. b/d	Corr., mpy Stat. 1	Corr., mpy Stat. 2
1	10-14-11-1	0	0	0	195	274.0	5.0
2	11-2-11-15	1.40	0.60	4.20	230	2.0	2.5
3	11-17-11-28	0.40	0.20	2.12	208	2.5	2.2
4	12-1-12-13	1.00	0.42	2.19	245	3.6	0.5

Gas is compressed from 90 to 110 psig., the temperature rising from 80 to 125° F. Then it is cooled by a series of G-fin type condensers, the condensate being sent to two 4 x 8 ft. accumulators. Water at pH of 7.3 is removed daily from these vessels in quantities ranging from several gallons to a barrel. The gasoline then is sent to two 10 x 30 ft. rundown tanks, from which it is pumped through a heat exchanger, raising its temperature to 225° F. before entering the depropanizer at 300 psi. Fig. 5 is the schematic flow diagram.

Prior to treatment with the organic inhibitor, the company experienced considerable expense due to plugging and tube replacement in the condensers. Corrosion also caused numerous leak repairs in the lines and damage to the accumulators and rundown tanks.

On November 3, 1950, treatment was initiated by injecting inhibitor into the line from the compressors, immediately preceding the condensers. On the first day, injection rate was 4.88 gals. 1000 bbls. of gasoline produced. On the second day, the rate was reduced to 2.44 gals. Subsequent treatment for the balance of a 14-day period was at the rate of 1.4 gals. for each 1000 bbls. Injection was by single daily batch additions. Data on the initial and two following 14-day runs are given in Table 5. The Station numbers, or test points, in the table correspond with those indicated in Fig. 2.

Corrosion at Station 1 has been reduced by more than 99% using less than 0.5 gal. of inhibitor per day. Corrosion at Station 2 was reduced by approximately 83%. However, the corrosion rate was not as severe as at Station 1 and, therefore, did not have as much room for improvement.

Two refiners lower corrosion in gasoline streams

The use of Kontol by an East Coast refinery and by one in the midwest is illustrated in the drawings in Figs. 3 and 4. Both plants are operated by companies who requested their reports to PETROLEUM PROCESSING remain anonymous. In one, Fig. 3, corrosion is being decreased in the condensers and reflux accumulators of a crude flash tower overhead system. Crude oil, pre-heated to 400° F., is introduced into the tower and a light straightrun gasoline taken off overhead. The condenser shells were suffering severe corrosion in the lower half (not shown in Fig. 3). Iron content of the water condensate was in excess of 10 ppm.

Kontol is now being injected into the vapor line continuously with a small proportioning pump at a rate of 2.5 gals./day. Iron content of the

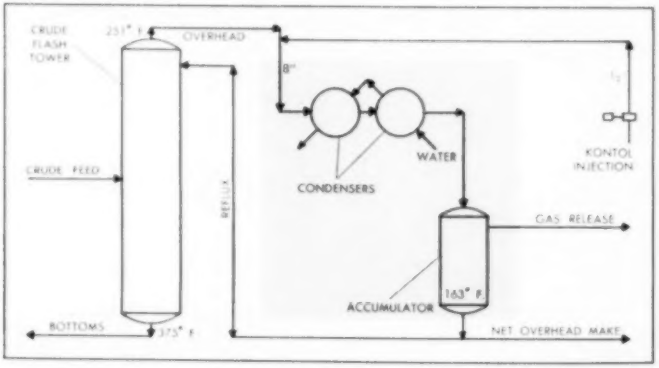


FIG. 3—Diagram of crude flash tower overhead condensing system.

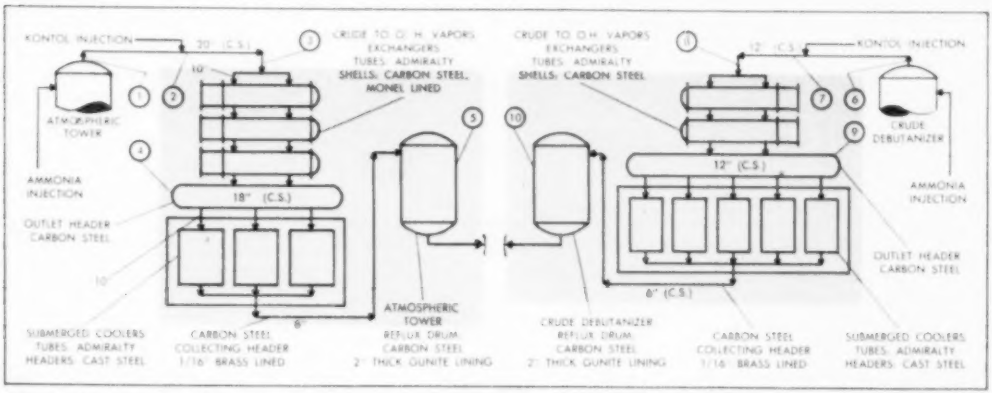


FIG. 4—Crude unit condenser and reflux accumulators (left), and debutanizer condensing system (right). Numerals indicate test stations.

condensate has been running about 1 ppm. since treatment began.

In the other refinery, corrosion is being combatted in the condenser and reflux accumulator sections of a crude flash tower and of a debutanizer used to stabilize straightrun gasoline. Prior to the use of Kontol, but while using aqueous ammonia to maintain a pH value of 8 on the water condensate, the iron content on condensate from the flash tower was about 34 ppm. and that from the debutanizer about 40 ppm. (Fig. 4).

The inhibitor is being fed to each system at about 1 gal. day. It is being injected intermittently, the daily dosage being pumped in over a one-hour's period in a 50-50 blend with kerosine. Ammonia has been continued to maintain a pH of 7. The iron content in both cases has been reduced to less than 1 ppm.

A number of test coupons have been placed in both systems. (See Fig. 4) to check loss of weight. However, no firm data is yet available.

Corrosion licked in natural gasoline plant too

A corrosion problem of a slightly different type was handled successfully by Kontol at the Lance Creek, Wyo. gasoline plant of Continental Oil Co.

This plant strips wet field gas of hydrocarbon vapors by compression, followed by cooling and also by absorption. The gas contains 3.6 gals. condensate per MCF., and it is saturated with water vapor. It contains from a trace to no H_2S and from 0.5 to 1% CO_2. The daily gas to the plant averages 20 MMCF, but since only the 550 psi. stage in the compression system has shown severe corrosion, the approximately 15 MMCF daily through that system is being treated.

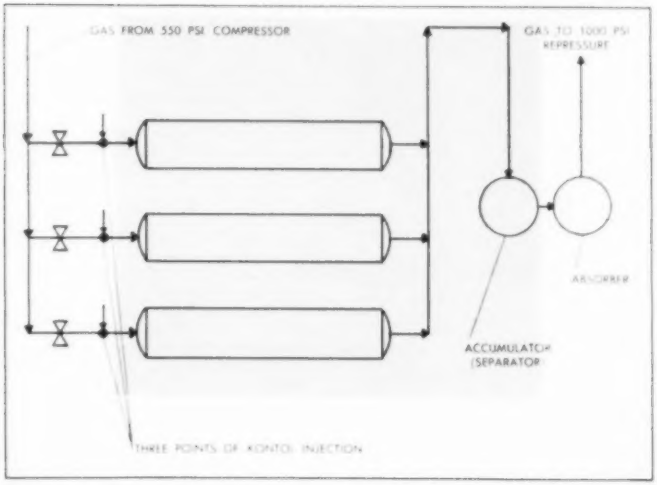


FIG. 5—Coolers, separators and lines in a gasoline plant subjected to corrosion.

Field gas at 5 psi. is compressed to 70 psi., cooled, and passed through a separator for removal of condensed water and hydrocarbons. This same operation is repeated at 230 and at 550 psi. All condensates are added to a common manifold. The gas is split into three parallel streams before passing through the 550 psi. cooling coils, each stream consequently handling about 5 MMCF day of gas. The gas makes six passes through the cooling coils, traveling from bottom to top, before going to the separators. After leaving the 550 psi. separator, the gas is passed through a counterflow absorber and then compressed to 1000 psi. and distributed to eight injection wells in the field.

Relatively severe corrosion occurs between the coolers and separators in the 550 psi. stage, and to a lesser extent between the compressor and wells in the 1000 psi. stage. Little corrosion has been noted in the wells or other sections of the plant. (See Fig. 5).

It was decided to run a corrosion prevention test in the 550 psi. stage by inserting test coupons through the header of the last (top) pass of the three sets of cooling coils, and then analyzing separator water for iron content. The coupons were to be changed every two weeks, and water samples were to be taken every week during the test period.

The third stage was then treated by daily batch dumping of a decolor-

Table 6—Corrosion Reduction in Coolers and Separators at Lance Creek Gasoline Plant

Test Period Dates, 1949	Inhibitor inject. rate gal. coil period quart coil day	Coupon corr. mpy Coil 1	Coil 2	Coil 3	Iron ppm.*
5-24-9/6	0	50.6	100.5	58.7	...
6-6-9/24	0	54.9	54.0	27.7	...
6-24-7/7	14.0	15.6	7.93	14.6	...
7-7-8/21	10.5	2.0	...	...	...
8-21-9/8	7.0	2.6	3.93	3.82	3.94	59
9/8-9/30	3.0	2.0	14.9	9.28	16.5	...
9/30-10/2	1.0	2.0	4.37	4.50	5.16	50
10/2-10/16	0.50	1.0	11.0	11.6	7.40	10
10/16-10/30	0.25	1.0	8.89	12.8	9.83	35
10/30-11/13	0.25	1.0	11.9	14.6	12.6	45
11/13-11/27	1.25	1.0	6.08	9.95	6.08	40
11/28-12/11	1.25	1.5	9.27	11.7	13.6	35

*Iron content of the separator water was made before treatment.

ized grade of Kontol into each of the three gas streams before they enter the cooling tower. Treatment has been successful. Data on coupon corrosion rates, in mills per year penetration (MPY), and on iron contents of separator water samples, in ppm, are shown in Table 6.

These data show very good protection was obtained at a treating rate of 7 gals. coil for the two-weeks period, or 2 qt. day/coil, which amounts to 1 qt. 2.5 MMCF gas. The coupons indicated a reduction of corrosion rate from the original 80 to 90 MPY to 3 to 4. However, when the treating rate was lowered to 1½ qt. coil/day, the corrosion rate rose to the unsatisfactory average of 11 to 13 MPY. Final treating rate was established at 2 qt. coil/day at that time.

For a period of months at the end of 1949, test coupons were changed less frequently. In May, 1950, it was necessary to clean each coil tube one at a time with hot water and steam, using a joint of ¾-in. pipe as a nozzle. On June 7, 1950, the rate of inhibitor injection was cut to one pint diluted in 7 parts of natural gasoline twice daily in each coil (1 qt. coil/day). Internal inspection of the 550 psi. accumulator (which had to be replaced once before because of corrosion) revealed no serious attack.

Since protection seemed to be good and the tube plugging continued, the injection rate was cut to ½ qt. coil/day, using two daily injections of a half-pint each. This rate is still in use.

Coupon corrosion test data since then indicate protection apparently has continued good except for one reading of 23.77 mpy. on one coil. Lance Creek plant engineers believe this is due to gas channeling through this coil because of worse plugging conditions in the other two coils. Gas temperatures support this theory. Gas volumes have been as high as 23,000,000 CFD, with up to 5,750,000 CFD through each coil during the last year. This reduced the Kontol rate to as little as one pint/5.75 MMCF gas at times.

It is now planned to install equipment to inject the inhibitor continuously through a Diesel nozzle. Experience in other locations indicates that this will stop the tube plugging which has been the only objectionable feature of the program.

Continental has tested and is continuing to check the effects of this inhibitor in refinery equipment corrosion, in a gasoline tower of a two-stage crude topping unit where attack is being encountered in the upper section.

Corrosion reduced 91% or more in steam stripper

Good results in reducing corrosion in stripping stills are being attained in an Illinois gasoline plant. This plant contains an absorber and two bubble cap stripping columns fed with the absorber oil. The gas being absorbed contains from a trace to 80 H₂S.

Steam at 350° F. is fed to the bottom of the stripping stills, and gasoline vapors are withdrawn from the top at 220° F. Absorber oil is fed to a middle tray and gasoline reflux to the top tray. Severe corrosion was experienced on trays and walls in the upper section of the columns, where liquid water is present. This water is withdrawn from the four bottom trays containing liquid water into two trays (two trays to a tray). This water is analyzed for iron.

Still No. 2 is fed with 432,000 gals./day absorber oil and 130,000 gals./day gasoline reflux. Iron contents before treatment were found to average 75 ppm., and the water from the trap was a rich red color due to iron oxide corrosion products. Kontol injection started June 10, 1949, is into the gasoline reflux line, consequently entering the still on the top tray. Injection is by means of a high pressure proportioning pump. The corrosion survey record of Still No. 2 is Table 7.

Still No. 1 is fed with 215,000 gals./day absorber oil and 60,000 gals./day gasoline reflux. Iron contents before treatment were averaging 160 ppm. Inhibitor injection was the same as that for Still No. 2, and was started October 3, 1949. Results on Still No. 1 are shown in Table 8.

Protection is being obtained in Still No. 2 with inhibitor-to-gasoline reflux ratio as low as 1-164,000, equivalent to 6 ppm. inhibitor concentration. Based on total absorber oil, concentration is 2.4 ppm. In the case of Still No. 1, corrosion rates were reduced 91%, using an inhibitor-reflux ratio of 1-67,200, or 14.9 ppm. concentration. Based on absorber oil, the ratio is 1-211,000, or 4.1 ppm. Plant engineers believe this may be reduced further with a longer period of treatment.

Changed Injection Point

During a three-week trial period, an attempt was made to change the injection point from the gasoline reflux line to the absorption oil stream, which enters the still near the center. However, iron contents of the water rose immediately to 150 ppm., even though the injection rate was 2 gal. daily of Kontol. This is explained by the fact that the inhibitor is non-volatile and heat stable, consequently was not distilling out of the absorber oil into the upper trays. Returning the injection point to the reflux line lowered the corrosion rate immediately.

The organic inhibitor is not intended to supplant the use of such commonly adopted methods already in use in refineries, such as ammonia injection of other means of pH control. However, when used in conjunction with other methods, it can

Table 7—Corrosion Reduction in Gasoline Plant Steam Stripper No. 2

Test Period 1949-1950	Inhibitor total	Inhibitor gal./day	Iron ppm.	Gals. inhibitor per gals. reflux
Before treat.	0	0	75.0	...
6-14	24.5	3.5	20.0	1-12,000
6-16	7.0	1.0	2.5	1-21,400
6-30	7.0	1.0	7.0	1-21,400
7-7 - 7-21	14.0	1.0	0	1-21,400
7-21 - 8-4	14.0	1.0	0	1-21,400
8-4 - 8-18	196.0	14.0	0	1-15,000
8-18 - 9-1	98.0	7.0	0	1-30,000
9-1 - 10-1	56.0	1.87	0	1-65,000
10-1 - 11-1	28.0	0.933	0	1-164,000
11-1 - 12-1	28.0	0.933	0	1-164,000
12-1 - 2-1	28.0	0.93	0	1-164,000
2-1 - 3-1	28.0	0.903	0	1-170,000
3-1 - 4-1	28.0	0.967	0	1-131,000
4-1 - 5-1	28.0	0.903	0	1-136,000

lengthen the expected life of equipment in corrosive service.

There are advantages other than the decrease in corrosion rates when Kontol is used in combination with ammonia, according to the manufacturers. When ammonia alone is used, refiners have had to compromise at a pH value which does not result in optimum corrosion control. This is because, at high pH, ammonia or other alkalies react with certain metals to form soluble metal salts. Admiralty, for example, is an alloy of copper and zinc widely used in heat transfer tubes. At a pH of around 8.0, zinc and ammonia will form a soluble zinc ammonium complex, resulting in dezincification of the alloy. And at a slightly higher pH, copper will form a copper ammonium complex. Therefore, complete destruction of the alloy can result unless pH is closely controlled.

Refiners have found that a pH of 7.5 to 7.6 is an optimum compromise point where both dezincification and corrosion can be controlled to a practical, though not optimum, rate. However, if Kontol is used along with ammonia, pH need not be maintained as high as 7.5 to 7.6. The pH can be controlled within the range of 4.0 to 6.0, where the organic inhibitor gives protection against corrosion, but the danger of dezincification or copper complex formation is negligible. This also affords savings in ammonia requirements, since the bulk of the ammonia is needed to raise the pH above 6.0.

Recently the manufacturer has been experimenting with a water-soluble form of Kontol designed for use, for example, in protecting Girbotol hydrogen sulfide removal units. Corrosion usually occurs in the overhead line from the still where H_2S-enriched ethanolamine is separated from the H_2S and water. Tests indicate that the inhibitor can be injected into the overhead vapor line to obtain good reduction in corrosion rates. Also, since it is non-volatile a considerable portion of the material returns to the column with the reflux and subsequently to the stripped amine solution leaving the still bottom to return to the main absorber.

Investigations are also being made on the use of the material as a corrosion-preventive additive for lubricating oils, particularly those oils which are used in field engines that burn raw, sour field gases. Another application already finding use currently is as an inhibitor, bactericide and algaecide in circulating systems for refinery and natural gasoline plant cooling towers.

Table 8—Corrosion Reduction in Gasoline Plant Steam Stripper No. 1

Test period 1949-1950	Inhibitor: total	Inhibitor: gal. /day	Iron ppm.	Gals. Inhibitor per gal. reflux
Before treat	0	0	160.0	
10-5-11-1	26.0	1.24	125.0	1-46,000
11-1-4-1	73.5	1.17	20.0	1-34,000
4-1-2-1	35.5	1.08	13.0	1-55,600
2-1-3-1	25.0	0.892	10.0	1-67,200
3-1-4-1	30.0	0.96	6.8	1-62,000
4-1-5-1	29.9	1.00	8.5	1-60,000

Acknowledgement

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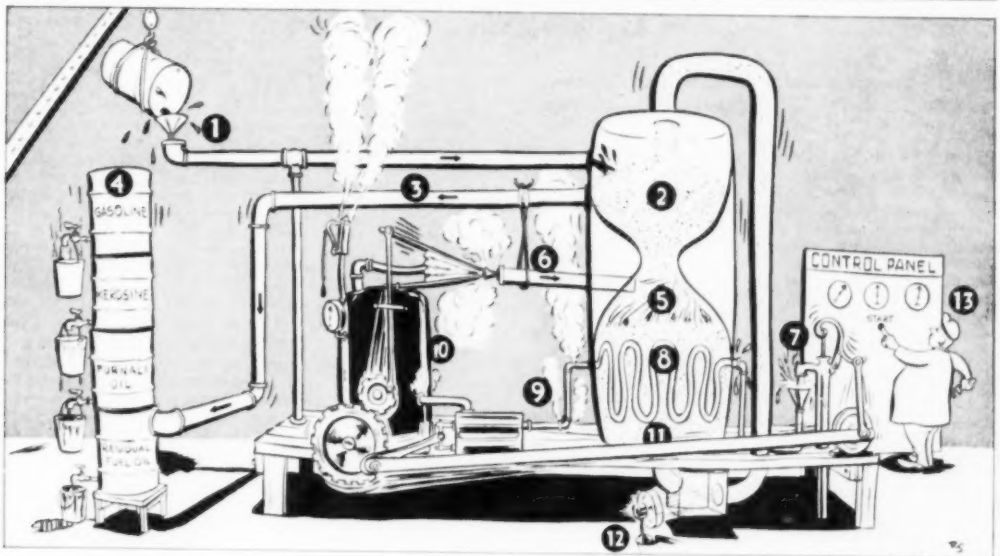

Courtesy Sun Oil Co.

Layman's flow chart of a Houdriflow unit. Taken from Sun Oil Co.'s *Our Sun*, this is an artist's impression of this cracking operation. Oil to be cracked (1) enters reactor (2) where it comes in contact with hot catalyst and cracking takes place. Cracked oil (3) leaves reactor, goes to fractionating tower (4). Catalyst flows downward into kiln (5) where air (6) is introduced to burn off carbon deposited on catalyst in cracking reaction. This is called regeneration. Water (7) is pumped through coils (8) around kiln to control heat of regeneration. The water becomes steam (9) which powers air blower (10) which supplies air for regeneration, which creates more heat to make more steam to supply more air, etc. etc. etc.

Meantime, regenerated catalyst leaves bottom of kiln (11), is picked up by air lift (12) and returned to top of reactor. (Actually, air which lifts catalyst is part of the air which has been used to burn carbon from the catalyst). As you can see (13) the whole operation is controlled automatically by operator at a control panel.

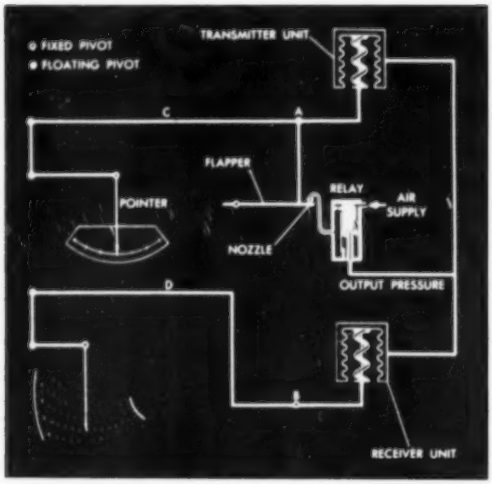

Fig. 68. Schematic diagram of a typical pneumatic transmitter-receiver.

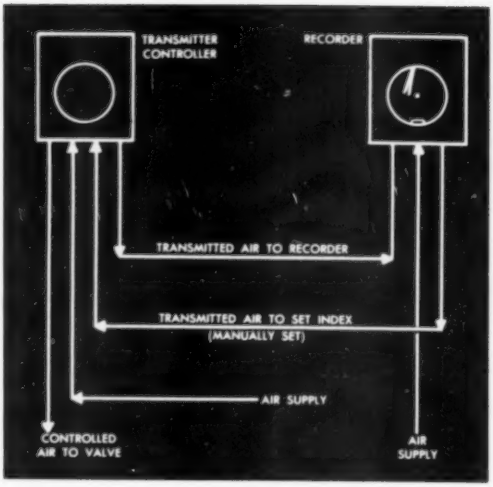

Fig. 69. Arrangement where transmitter includes a control mechanism.

REFINERY INSTRUMENTS

What Makes Them Tick?

Part 8—Pneumatic Transmission

By CORNELIUS E. SHANNAHAN, Instrument Engineer
M. W. Kellogg Co., New York

FUNDAMENTALLY, the control cycle is now complete. But no discussion of instrumentation would be complete without some mention of pneumatic transmission and other pertinent equipment which cannot be classified in any particular category.

The necessity of centralizing essential instruments went hand in hand with the increase in size and complexity of refineries. It is easy to picture the difficulty which would arise if it were necessary for an operator to tour present-day units in order merely to appraise their operation, let alone the prodigious task of bringing about control in the event of an upset.

Consequently, as the need for centralized instruments, located in what is called the control room, came into being, another problem arose due to the distance introduced between the control board-mounted instruments and their points of measurement.

For example, it is conceivable that an orifice of a flow instrument to be located in the control room could be 500 ft. away. Not only would it be cumbersome to pipe the taps to the board-mounted instruments and to introduce lag in the measuring element, but it would complicate no end those installations which require sealing and or steam tracing. To overcome this difficulty locally-mounted transmitters are installed. For the previous example, the transmitter would be located as close as possible to the orifice, would measure the differential across the orifice, and would transmit pneumatically its reading to the board-mounted instrument.

Illustrated in Fig. 68 is a schematic diagram of a pneumatic transmitter and a receiver, with the latter conceivably located on the control room instrument board. Although not shown, the pointer of the transmitter would be positioned for our example by float movement in a mercury manometer. The transmitter and receiver bellows are identical and are in effect proportional bellows. As the pointer moves to cover the flapper, the output pressure increases until the bellows restores the flapper-nozzle relationship to its tangential position. And also, as was the case with proportional bellows, for every position of the pointer there will be a corresponding output pressure. Since the receiver bellows is identical to the transmitter bellows, the receiving pen will duplicate the position of the transmitter pointer. If the re-

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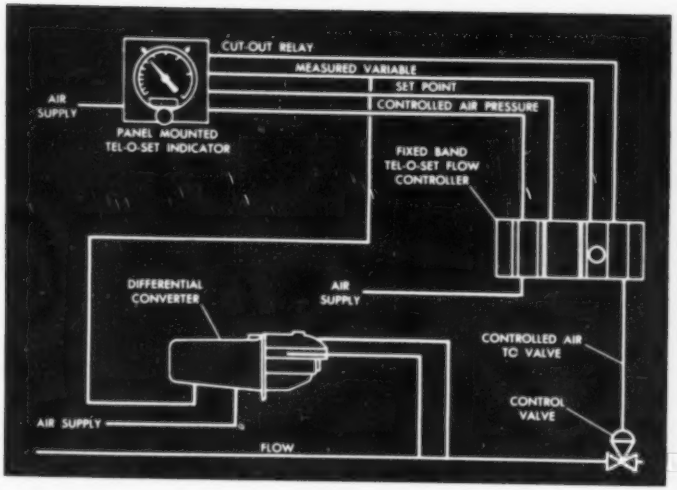

Fig. 70 Typical design for using pneumatic transmission with graphic panels

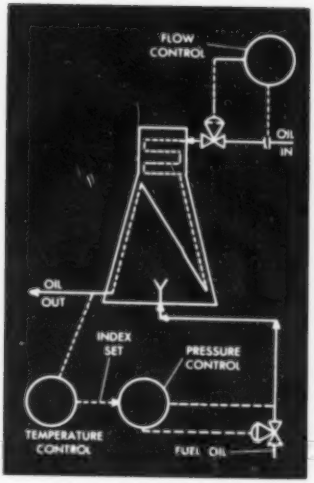

Fig. 71 Process example illustrating "pneumatic set" or "cascade" control

ceiver were a recorder controller, it would differ from those described in Part 6 (PETROLEUM PROCESSING, December, 1951, pp. 1371-91) only in that the measuring element would be replaced with a mechanism for receiving the reading of a transmitter.

Where pneumatic transmission is used, it eliminates the necessity of bringing hydrocarbons into the control room for measuring purposes. Some refiners make use of this arrangement, and by pressurizing the control room classify it as a less hazardous area in order to reduce the amount of explosion-proof equipment.

There are a number of other ways in which pneumatic transmission is used today. One variation is illustrated in Fig. 69, where the transmitter not only includes the transmitter element but also the control mechanism proper. Provision is also made so that the operator can conveniently vary the control index point of the local controller from the control board-mounted recorder. This is accomplished by the same type of matched pneumatic bellows previously described. However, in this case the control index pointers are connected to their respective bellows and match position as the index of the receiver-recorder is varied manually. This arrangement in a modified form is the fundamental basis for installation on many units where graphic panels are used.

Automatic-Manual Switch

Before developing this phase any further, one feature which is practically "standard" with all controllers should be explained. And that is that each controller is furnished with a switch and built-in air pressure regulator which permits an operator to by-pass the instrument's automatic circuit and position the valve simply by throttling the regulator. This feature is invaluable during start-ups and also in the event of a failure of any part of the control mechanism.

In the conventional arrangement, i.e., controller mounted in the receiver, the automatic-manual feature is conveniently centralized in the control room, whereas with the arrangement illustrated in Fig. 69, it would be necessary for an operator to go out to the locally-mounted instrument to make these adjustments.

The disadvantage of this type of hook-up carried throughout a large refinery can easily be appreciated. To make the automatic-manual switch equally accessible on those installations where the controller is removed from the control-board-mounted instruments (which is true of most graphic panel designs) additional tubing runs and equipment are added so that the manual by-pass can be performed from the control room. A typical installation for a graphic panel is illustrated in Fig. 70.

The "cascade" system is still another form of control which deserves mention here. In a cascade system, the output pressure from one controller pneumatically sets the control point of another. Before going into an explanation of the mechanics of cascade control, or as it is more commonly referred to as "pneumatic set," the philosophy of how a pneumatic set instrument might be applied to a typical problem is suggested.

For the process illustrated in Fig. 71, it is desired to maintain a constant oil outlet temperature. With the charge oil inlet being held constant by means of a flow controller, the simplest arrangement to control oil outlet temperature would be for the oil outlet temperature controller to throttle the fuel oil control valve directly. The disadvantage of this arrangement is that changes of pressure in the fuel oil system, which would result in fluctuation of fuel rate, would not be recognized until the oil outlet temperature changed.

One possibility might be to put a pressure controller in the fuel oil system and then the oil outlet temperature would only be recorded. With this system, however, it would be necessary for the fireman to change manually the control point of the fuel oil pressure controller from time to time so as to counteract variables that neither the flow nor the pressure instrument control; i.e., coking in the tubes, change in heating value of the fuel, ambient conditions, etc.

The ultimate, therefore, would be for the oil outlet temperature controller to set automatically the control point of the fuel oil pressure controller, as illustrated. In this way, any changes that neither the oil inlet flow controller nor the fuel oil pressure controller have control of, would be recognized by the oil outlet temperature controller. This instrument would then increase or decrease automatically the control point of the fuel oil pressure controller. There are, of course, other solutions to this problem, the purpose here being only to illustrate how two controllers can be integrated.

Pneumatic Set Mechanism

The mechanism for a pneumatic set instrument is illustrated in Fig. 72. The oil outlet temperature controller is usually referred to as the Master Controller and differs from other controllers only in that instead of its output pressure being transmitted to a valve, it is transmitted to a secondary instrument. The secondary instrument would be the fuel oil pressure controller and is called the Pneumatic Set Controller.

Air pressure from the master con-

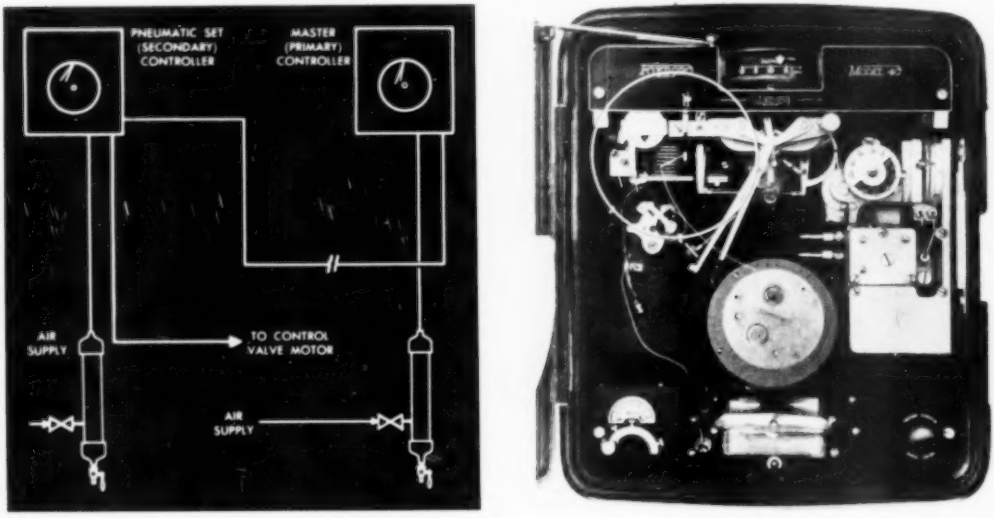

Fig. 72—Mechanism of a pneumatic set instrument.

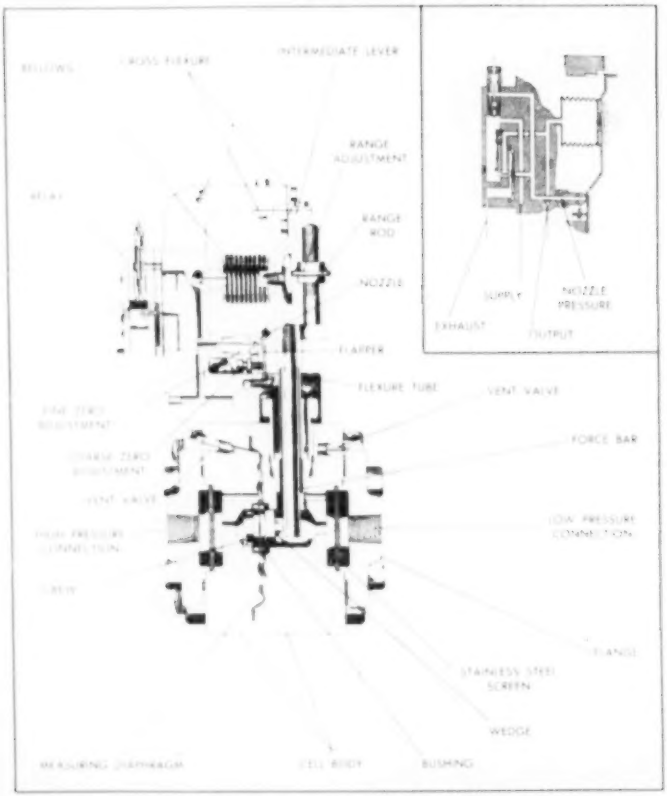

Fig. 73—Mechanism of a force balance type pneumatic transmitter.

troller enters the pneumatic set bellows of the pneumatic set controller and positions the control index. With the exception of the added pneumatic set mechanism, the secondary controller is identical to any conventional controller.

Force Balance Cells

Recently, considerable interest has been centered on force balance cells which are used almost exclusively as pneumatic transmitters for measuring some form of differential pressure, be it pressure, flow, or level. As a typical example, consider the application of a force balance cell for flow measurement. Instead of measuring the differential pressure across an orifice by means of a mercury manometer as outlined in Part 1 (PETROLEUM PROCESSING, July, 1951, pp. 730-51), the force balance cell utilizes the theory by which it is named.

As illustrated in Fig. 73, the high and low pressure taps are piped to their respective sides of the cells. When a differential is created, the unbalance is detected by the diaphragm, which produces a force on the force bar. The force bar transmits its motion to the range rod which in turn imposes a force on the intermediate lever. The force imposed on the intermediate lever is exactly proportional to the differential pressure across the diaphragm.

The sequence of operations that follow are exactly analogous to the proportional controller. If, for instance, the intermediate lever has been moved so as to cover the nozzle, the output pressure as well as the pressure in the bellows will commence to increase. The pressure in

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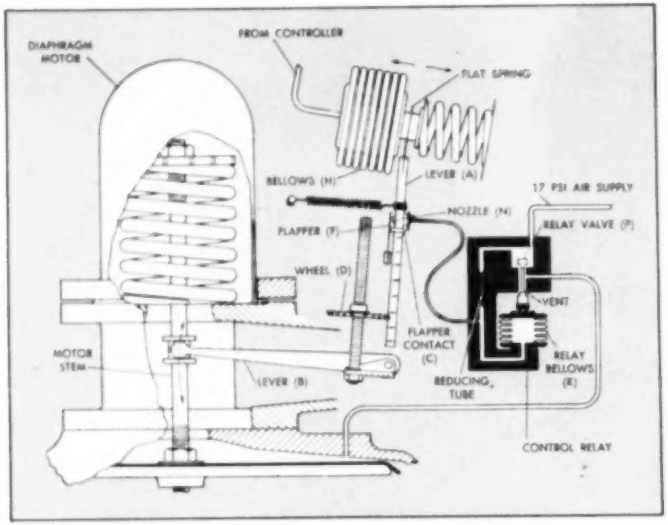


Fig. 74. One type of pneumatic valve positioner.

the bellows will continue to increase until it balances the force imposed on the range rod and restores the intermediate lever as well as the flapper-nozzle relationship to its original position.

In order for the intermediate lever to remain in a fixed position, the force created by the bellows must be proportional to the force of the range rod, which in effect is proportional to the differential pressure. Since the force in the bellows is proportional to the air pressure in it, it follows then that bellows or output pressure can be interpreted as a measure of differential pressure. A few of the advantages of the force balance cell over the conventional mercury manometer are 1) it requires no mercury, 2) has an adjustable range, and 3) its simplicity of installation and calibration.

Valve Positioners

Although the subject of valve positioners may seem misplaced in a discussion of pneumatic transmission,

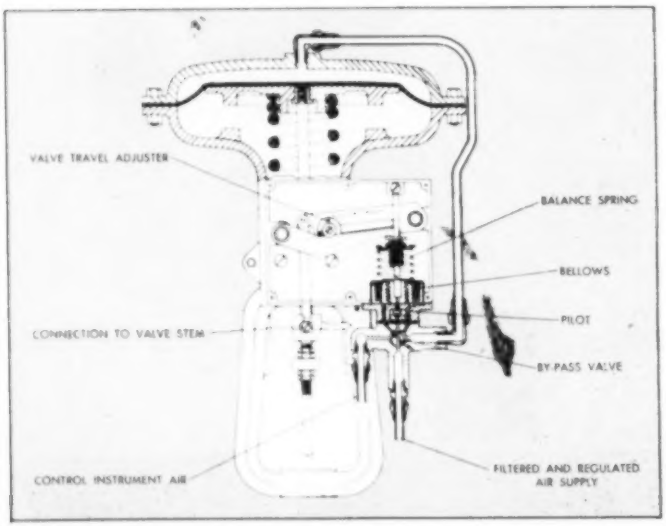


Fig. 75. Another type of pneumatic valve positioner.

one of the contributing reasons for their existence is the long transmission lines between the controller and the valve. More important, however, their operation is somewhat analogous to a transmitter. A few of the services for which valve positioners are usually recommended include:

1) With controllers requiring wide proportional bands and long reset times, such as temperature controllers.

2) Where the distance between the control pilot and control valve is excessive or the volume of the diaphragm head is large (Usually valves 6 in. and greater).

3) Where the control valve is unbalanced either inherently such as a single-seated valve or because of excessive pressure drop.

4) Where the stuffing box friction is high due to the high pressure of the flowing material.

One type of valve positioner is illustrated in Fig. 74. From the illustration and the following description of its operation, it will become evident that it has the same function as a proportional controller.

Air entering the bellows *H* from the controller expands the bellows, rotating lever *A* to the right about the point where it contacts wheel *D*. In so doing, flapper *F*, following the flapper contact *C*, covers the nozzle and thereby increases the air on the diaphragm. As the valve stem is forced downward, it rotates lever *B* counter-clockwise, which moves wheel *D* to the left. This results in the lower part of lever *A* rotating to the left to restore the correct flapper-nozzle relationship to maintain the new pressure on the diaphragm. As in the case of the proportional controller, it follows that for every controller output pressure, there is only one corresponding position of the valve.

Another type of valve positioner is illustrated in Fig. 75. A change in the control instrument air pressure operates the bellows, which in turn moves the pilot to either admit a supply of air to the diaphragm or exhaust from the diaphragm to atmosphere past the upper pilot stem. As the valve responds to the change in pressure on the diaphragm and the valve stem moves, a different force is exerted on the balancing spring through the connecting levers. The change in loading on the spring opposes the movement of the bellows and restores the balance between the spring loading and the bellows for the new control instrument air pressure. A by-pass valve is usually installed, as illustrated, for the purpose of connecting the air from the control instrument directly to the diaphragm of the control valve.

Conclusion

Although the physical appearance may vary with the manufacturer, one could expect to find in any modern

What Makes Instruments Tick?

refinery today the same basic concepts of instrumentation as described in this series of articles. We must keep in mind, however, the tremendous strides the instrument industry has made in the past decade, added to the already foreseeable improvements of tomorrow, which leave every indication that a continuous review is necessary to keep abreast of developments.

For example, a short while ago the use of graphic panels was considered novel. Today, they are becoming commonplace. Unfortunately, certain compromises have been necessary to date with the acceptance of graphic type instruments. To name one, on most graphic installations in order to conserve space the controller is removed from the receiver, or usually located so that it is necessary to tune the instrument "blindly" so to speak. With the conventional instruments, the proportional, reset, and other settings if included, are all accessible from the front of the instrument case so that it is possible to observe readily results as the instrument is tuned.

Many pros and cons exist, of course, regarding graphic instruments. The point here is that improvements are being made continually to retain the features of conventional instruments as well as offer the advantages of the graphic. Many authorities feel the eventual answer to these endeavors will be realized in electronic instruments. In other words, all functions being performed pneumatically, with the possible exception of the valve operator, would be accomplished by means of electronics. There are many obstacles to surmount, of course, but it is interesting to note that only a short while ago the use of an electronic instrument, with its supposedly fragile tubes and high voltages was practically unheard of in a refinery area. Today, electronic instruments are used extensively, especially in the temperature measuring field. With the other advantages a complete electronic instrument has to offer, it seems natural to expect greater inroads from this direction.

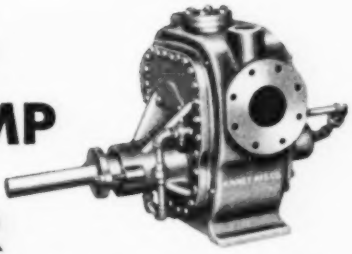
Then too, as new processes are introduced, it is to be expected that there will be greater impetus given to the more general use of gas analyzers as controllers and recorders, servo-mechanism techniques, and other developments.

All of these trends lead eventually to the push-button, or robotized, plant, once regarded as the "pipe dream" of some over-enthusiastic instrument engineer. Perhaps this best expresses the need for those who are interested in remaining well informed that a continuous review of developments is necessary.

Picture Credits

Illustrations in this article were furnished through the courtesy of Foxboro Co., Minneapolis-Honeywell Regulator Co., Brown Instruments Division, and Moore Products Co.

THE PUMP FOR ASPHALT



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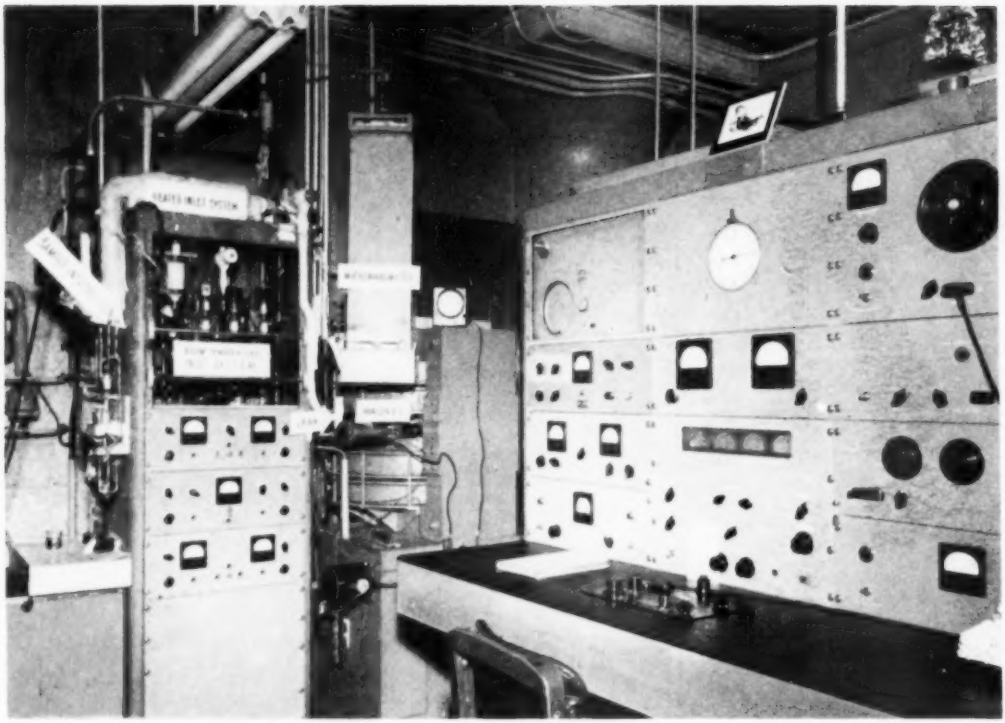

GAS, LIQUID, or SOLID SAMPLES can be handled in this mass spectrometer used by Atlantic Refining Co.

Analysis from Gases to Waxes by . . .

Mass Spectrometry

By R. A. BROWN, F. W. MELPOLDER, and W. S. YOUNG
Atlantic Refining Co.

THE first commercial mass spectrometer to find a place in the analytical laboratory was the Model No. 21-101 instrument built in 1942 by the Consolidated Engineering Corp. The Atlantic Refining Co. was fortunate in obtaining this first instrument and applied it immediately to the analysis of refinery gas streams containing methane to butane.

In this application, it aided materially in the initial start up of a fluid catalytic cracker. Due to the speed and reliability of analysis, the mass spectrometer largely replaced the conventional low temperature distillation method. During the intervening years there has been a rapid extension of this original application to include liquid hydrocarbon mixtures of increasing molecular weight[1] as well as mixtures of organic compounds containing oxygen, sulfur, nitrogen, and the halides[2,3,4].

The ability of analytical mass spectrometers to analyze mixtures of a complex and diverse nature has been amply demonstrated in many laboratories of the petroleum and chemical industries. Generally, such analyses are carried out in a routine manner using technical and semi-technical man-power in a way that reduces the cost of each analysis to a fraction of what former methods entailed.

As a rule, also, spectrometric methods yield more complete information more accurately than previously employed chemical or physical techniques such as, bromination, hydrogenation, sulfonation, fractional distillation, adsorption methods and refractive index measurement. It should be emphasized, however, that these latter methods frequently serve as excellent supplementary tools for mass spectrometer analysis.

The early development of the analytical mass spectrometer and its applications was concerned chiefly with techniques of sample introduction, sorption effects, methods of computation, and maintenance problems. An introduction to the method[5,6] and summary of early applications[7,8] have appeared in the literature and need not be discussed in detail here.

A new type of analysis[9,10] was introduced recently when it was found that gasoline components could be quantitatively determined according to hydrocarbon types. The applicability of the mass spectrometer to this sort of analysis was determined from a study of the mass spectra of a large number of C_5 to C_{10} compounds. Comparison of these various spectra showed that ions which appeared at certain m/e ratios were generally most abundant in paraffins.

Similarly, relatively large peaks at other m/e ratios appeared to be characteristic of the cycloparaffins and monoolefins, whereas ions at still different masses were contributed by cycloolefins, diolefins, acetylenes and aromatics. When the peaks in each of the above groups are mathematic-

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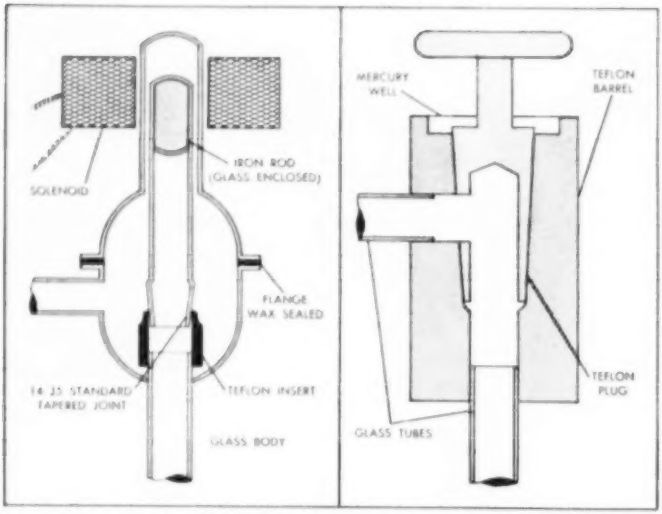

FIG. 1—ONE PROBLEM in mass spectrometry that of sorption effects of glass stopcocks was eliminated by these Teflon fittings: solenoid valve at left, and stopcock at right

ally combined and treated as one, it is found that pattern coefficients of combined peaks are similar for compounds of the same type, but for dissimilar compounds show marked differences. Furthermore, sensitivities of these peaks are found to be directly related to molecular weight.

These properties make it possible, then, to consider complex mixtures as consisting of only four components which may be resolved with four simultaneous equations. Analysis of a sample requires accurate sensitivity data as well as proper pattern coefficients. Since it is not feasible to run a large number of calibrations with each unknown sample, it appeared necessary to relate sensitivities with a standard such as normal butane. A study of this possibility showed combined peak sensitivities to be directly related to that of normal butane at mass 43 irrespective of the ion source and operating conditions.

An important factor which accelerated the development of mass spectrometry was the availability of pure calibration compounds. Pure hydrocarbons were provided by a joint effort of API projects 6, 42, and 45. A total of 184 hydrocarbons in the gasoline boiling range and 29 hydrocarbons in the lubricating boiling range were synthesized and purified.

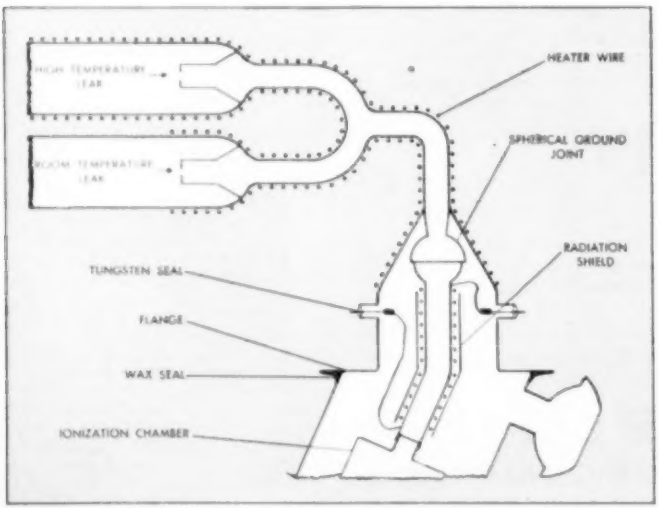

FIG. 2—Part of the heated inlet system for mass spectrometer samples

Experimental

One of the most annoying problems in the introduction of samples to the mass spectrometer was sorption of samples in stopcock grease and on glass wall surfaces in the inlet system. The first systems were limited to the introduction of compounds having vapor pressures of at least 50 mm. Hg. Eventually the ability to handle materials of vapor pressure as low as 0.05 mm. was accomplished in a number of ways. Various laboratories found these difficulties could be partially overcome by replacing the greased stopcocks with cut-offs or valves[9], by heating parts of the inlet system[10], and by replacing the glass leak with a gold one located near source of ionization[4].

In line with this, O'Neal and Wier[7] recently described a modified Consolidated 21-102 mass spectrometer with which it was possible to obtain resolved spectra out to mass 600. This development represents a major contribution to mass spectrometry and was of wide spread interest to analytical chemists. A typical application was illustrated by the analysis of a wax of average molecular weight 350. n-Paraffins, isoparaffins and naphthenes were quantitatively determined according to molecular weight. Data made available in this manner has never before been possible and will undoubtedly advance the technology of wax manufacture to a considerable degree. Other applications of equal worth will undoubtedly follow.

The gradual evolution of the mass spectrometer in this laboratory dealt with each of the problems and developments mentioned above. This has resulted in an instrument which will operate equally well at sample pressures of only 0.05 mm. with compounds of the highly polar type which normally adsorb strongly on glass, and with high molecular weight samples having negligible vapor pressure at room temperature.

The conventional greased stopcock introduction system was replaced with mercury covered sintered discs and mercury cut-offs[9], and later with a Teflon stopcock and solenoid valves as seen in Fig. 1. Sorption effects on glass were eliminated in two ways; first, by moving the leak close to the ion source, and second, by heating the inlet tubing.

In order to analyze high molecular weight samples, a second heated introduction system was constructed and placed in parallel with the one at room temperature. The high temper-

ature part of the equipment consists of a glass bottle heated to 550 F. with Hoke stainless steel diaphragm valves replacing stopcocks. The glassware and valves are heated by means of wire wrapped externally around their periphery. The precision tubing leading directly to the ionization chamber is heated as shown in Fig. 2. An air stream is used to cool the wax seal which joins the transfer line to the envelope tube. The entire sample inlet section is shown in Fig. 3.

Liquid and solid samples are introduced either through a sintered disc sealed with molten gallium or the valve assembly sketched in Fig. 4. This latter apparatus was found to be particularly advantageous for solids having high melting points and for determining sensitivity values since a PVT calculation could be used to obtain sample pressures. Sample volumes constant within ±3% can be delivered with this valve.

The high temperature apparatus has been in use for a year and a half during which time well over two hundred relatively pure compounds have been run along with more than two thousand mixtures for analysis. Representative samples include kerosine, furnace oil, gas oil, wax and a number of oxygenated, nitrogenous, and sulfur compound mixtures.

Applications

Work done with the authors' mass spectrometer is dictated by the needs of a relatively large research and development department. Analyses obtained are used for studies of various refinery processes including: fluid bed catalytic cracking, thermal cracking, alkylation, naphtha blending, treating, and solvent dewaxing. In addition, a large number of samples originate from pilot unit operations and numerous chemical product research projects. Because of the varied nature of requested analyses, useful applications for our modified spectrometer was readily realized and because the work deals with a number of different problems, this part of the discussion has been sub-divided into petroleum and chemical applications.

Petroleum

Volatile Products — These include gases, naphtha, alkylate, polymer, gasoline, and a wide variety of special fractions. In general, gas analysis almost invariably yields satisfactory results without fractionation due to the relatively small number of isomers present.

In contrast, the analysis of liquid products can only be done by carrying out spectrometric analyses on a series of close boiling fractions. These fractions, however, have been obtained from the whole naphtha or distillates

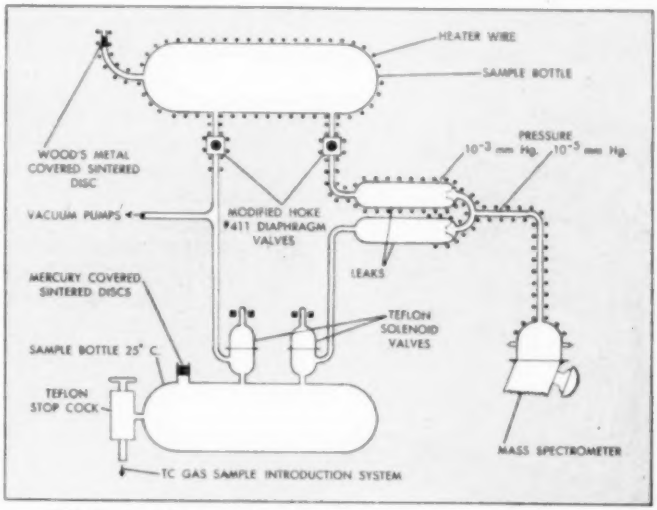

FIG. 3—Complete sample introduction system for mass spectrometer

by a somewhat elaborate technique. The distillate is split into several large fractions which usually correspond to differing molecular weight groups. These are then separated into hydrocarbon types by percolation through silica gel[5].

The resulting paraffin-cycloparaffin, olefin, and aromatic portions are then refractionated in a 100-plate column and spectrographic analyses made of these fractions, or combination of fractions. Olefin fractions are difficult to analyze directly because of the large number of isomers present and the lack of calibration standards in the form of pure olefins. These fractions are therefore hydrogenated first and the resulting paraffins are analyzed by mass spectrometry.

These techniques were employed in the analysis of a naphtha from fluid catalytic cracking[6]. Ninety-two individual hydrocarbons including twenty-one olefins, in addition to sixty groups or classes of compounds were determined. A very useful method for characterization of liquid samples is the Pona analysis[1] described earlier. Analyses of hydrocarbon types in refinery and pilot plant streams serve as excellent checks on operation.

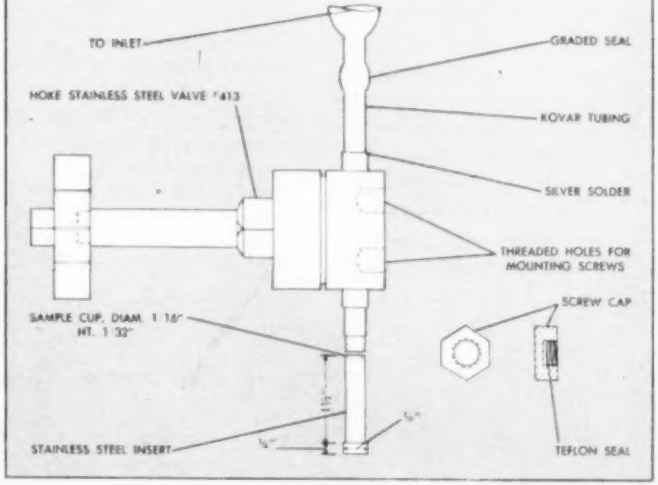

FIG. 4—Apparatus for introducing liquid and solid samples

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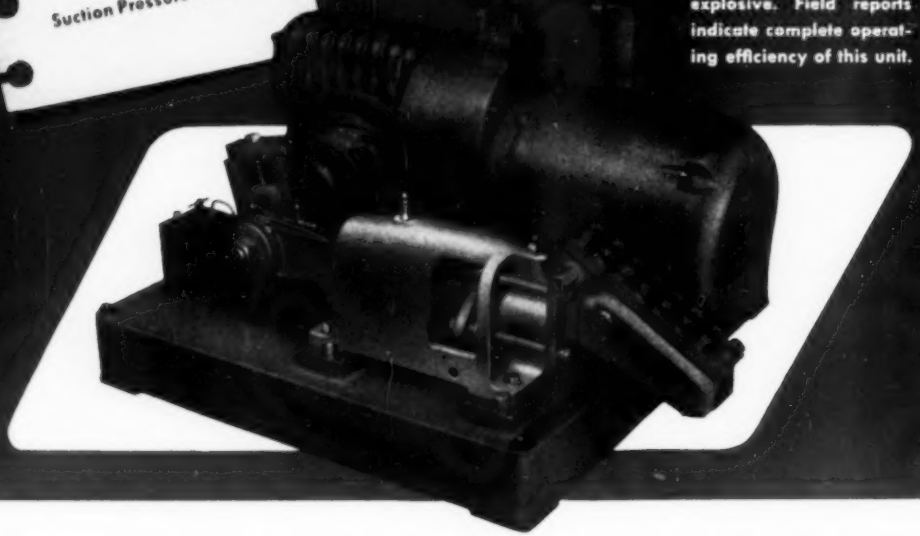

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Kerosine and Gas Oil—Current interest in furnace oil and jet fuel composition prompted a study as to the feasibility of determining compound types present in petroleum fractions of boiling points ranging from 250° F. to 650° F. Analyses obtained in this way are at least semi-quantitative in nature and somewhat more informative than previous ones based on chromatography and physical measurements of resulting percolates[3]. The spectrometer method, as a matter of fact, could well be supplemented by analyzing chromatographic fractions instead of whole samples.

Compound type analysis was obtained for three different gas oils each in the boiling range 250° — 650° F. These samples were representative of a straight run stock (Venezuela Crude), a catalytically cracked material, and one obtained by thermal cracking. As expected, the cracked samples were relatively high in aromatics with the thermally cracked gas oil being mostly aromatic. This last mixture also had the highest bromine number indicative of olefinic compounds. These data are tabulated in Table 1 and compound types reported include: paraffins, cycloparaffins, alkyl benzenes, naphthalenes, tricyclic aromatics, as well as two other groups of dicyclic paraffins and aromatics.

Wax—A wax of average molecular weight 280 was distilled at one micron pressure into eleven fractions which were analyzed as shown in Table 2. A direct analysis of the whole sample compared favorably with the composite analysis as shown.

If may be seen, however, that some of the individual fractions (Cut 10 and the residue) contain 0.42% of isoparaffins not detected in the whole sample. Results are summarized in Table 3 and it is of interest that the molecular weight of 281 calculated from mass spectrometer analyses agrees well with the 274 value determined by an ebullioscopic method.

An interesting feature of this analysis was the appearance of an apparently extraneous material of molecular weight 294, in fractions 1-5. It was considered unlikely to be hydrocarbon as no neighboring molecular weight isomers were detected and also none of this compound was found in the direct analysis of the whole sample. Subsequently, it was suspected to be contamination originating in the distillation apparatus.

Table 1—Mass Spectrometer Analysis of Gas Oils

	Straight Run (Venezuela Crude)	Catalytically Cracked	Thermally Cracked
A.S.T.M. 10% (° F.)	380	476	424
90% (° F.)	585	693	636
Bromine No.	0.8	2.4	6.2
Component		**Wt. %**	
Paraffins	40	42	21
Cycloparaffins			
Monocyclics	32	11	13
Dicyclics			
Acenaphthalene, etc.	3	7	6
Alkyl Benzenes	10	7	17
Alkenyl Benzenes			
Tetralins	8	4	8
Phenyl cycloparaffins			
Naphthalenes	5	15	29
Diphenyls			
Acenaphthenes, etc.	2	9	6
Tricyclic (anthracene, etc.)	2	5	1
Totals	100	100	100

Chemical

Aromatic Stocks—Production of aromatic stocks is an integral part of many chemical processes. In this laboratory, a large number of such mixtures have been analyzed and typical of such results are the known blends shown in Table 4. Narrow boiling fractions consisting essentially of an alkyl benzene of one molecular weight were analyzed and then blended as indicated. Mass spectrometer analyses agreed within ±1-3% of the known composition. Analytical results of this nature have become of increasing value to detergent production in particular.

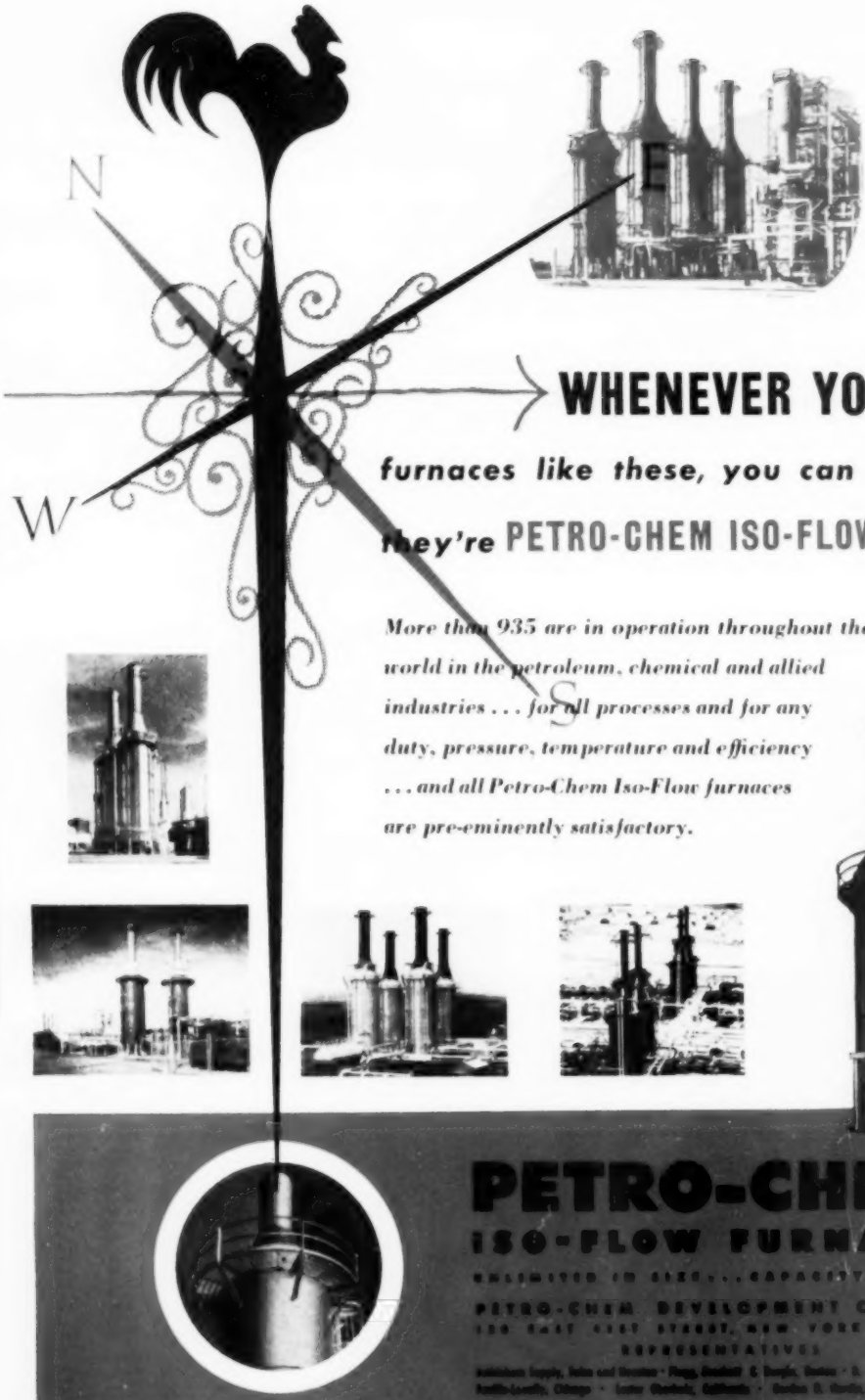
Wax Solvents—Dewaxing operations are carried out commercially using a solvent consisting of benzene, toluene and methyl ethyl ketone. Analyses are frequently obtained of this mixture as well as batch still products obtained during purification of the solvent after it has been used. These products contain appreciable amounts of nitrobenzene and phenol which are extracted with the waxes. As seen in Table 5, such samples can be analyzed with fair accuracy and serve to check chemical determinations.

Phenols—Crudes contain small amounts of naphthenic acids and phenols which can be freed from the crude by caustic extraction followed by neutralization. A mixture of phenols obtained in this way was found to consist of compounds ranging in molecular weight from 94 (phenol) to 164, presumably an amyl substituted phenol (see Table 6). Before these data were considered valid the mass spectrometer was tested with a known mixture consisting of cresol and amyl phenol which was analyzed with a ±1% error.

Maleic and Succinic Compounds—Maleic anhydride has attracted considerable interest during the past few years as a versatile chemical intermediate. Careful analysis of a pilot

Table 2—Mass Spectrometer Analysis of Wax and Wax Distillates

Mol. Wt.		Cut No. 1	2	3	4	5	6	7	8	9	10 Iso.	10 Norm.	Residue Iso.	Residue Norm.	Composite Iso.	Composite Norm.	Direct Anal. of Original Sample Norm.
		Normal Paraffins															
212	(C15)	0.7	0.2														0.3
226	(C16)	1.4	0.4	0.7	0.4												0.6
240	(C17)	5.9	3.4	1.7	1.0	1.5	0.2										1.5
254	(C18)	20.6	17.9	13.0	8.7	5.0	1.7	0.4					0.7				1.5
268	(C19)	33.5	39.1	38.7	37.7	31.3	21.3	18.0	9.1	3.9		1.4	0.9	5.9	(90)	7.31	7.5
282	(C20)	23.1	28.2	32.6	36.6	42.6	47.8	48.4	44.6	34.3	0.6	12.5	0.9	8.7	(95)	24.58	25.5
296	(C21)	7.8	7.7	9.8	11.4	16.1	23.2	26.3	35.2	41.6	0.6	33.8	1.7	7.2	(96)	34.25	34.5
310	(C22)	1.1	0.3	1.7	2.2	2.9	4.9	5.7	8.0	15.3	0.6	27.0	1.3	7.7	(96)	19.88	19.6
324	(C23)				0.4	0.4	0.8	1.2	2.1	4.3	0.6	12.8	1.3	6.2	(96)	6.64	6.9
338	(C24)									0.6	0.6	5.0	1.3	3.8	(96)	2.08	2.0
352	(C25)										0.5	2.4	4.3	3.8	(94)	0.57	0.7
366	(C26)										0.3	1.8	1.6	2.8	(94)	0.26	0.5
380	(C27)												1.8	5.5	(94)	0.21	0.4
394	(C28)												2.2	8.2	(91)	0.05	
408	(C29)												2.3	8.7	(91)	0.05	
422	(C30)												2.4	8.0	(91)	0.05	
436	(C31)												2.8	4.2	(81)	0.03	
													1.7		(91)		
															(419	98.29	100.0
															1.13		0
294		4.0	2.7	1.8	1.6	0.2										99.94	100.0



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REPRESENTATIVES

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unit maleic anhydride product led to the identification of a large number of acids and aldehydes. Many of these were easily separated from the anhydride by a simple distillation although small amounts of a material of similar boiling point could not be removed in this manner. After some effort this substance was eventually identified as succinic anhydride.

It is of interest that the clue which led to the identification of succinic anhydride was the presence of breakdown peaks which occur from decarboxylation of the parent molecule. It was observed that the mass spectrum of maleic anhydride, for instance, had large peaks at masses 54 and 26 which presumably are formed according to the process:

$$(CH{=}CH{-}CO)_2O \rightarrow (CH{=}CH{-}CO)^+ + CO_2$$
mass = 98 mass = 54 mass = 44

and:

$$(CH{=}CH{-}CO)_2O \rightarrow (CH{=}CH)_2 + C_2O_2$$
mass = 98 mass = 26 mass = 72

With these reactions in mind, unaccounted for peaks occurring at masses 56 and 28 led to the conclusion that succinic anhydride was present inasmuch as this compound has the same structure as maleic anhydride except for two additional hydrogen atoms.

In connection with this analysis a study was made of the acids and their anhydrides. Maleic and succinic acids, which decompose at their boiling points of 135° C. and 235° C. respectively, when introduced to the heated inlet system thermally decompose to yield anhydride and water which then behave as a two component mixture. Data in Table 7 demonstrate the manner in which this is confirmed by mass spectra. The spectra of acid and anhydride are essentially the same except for the presence of water which appears at masses 17 and 18.

In addition to the specific application discussed above, there are innumerable instances where the mass spectrometer has played a major part in resolving research and process problems. Recently it has become evident that results obtained from the mass spectrometer should be closely coordinated with those from optical spectrometers such as infrared, ultraviolet and Raman in order to obtain the maximum amount of information in the analysis of complex mixtures, or to obtain complementary or supplementary information on materials of unknown origin. In so far as the future of mass spectrometry is concerned, the development of newer methods, techniques, and apparatus is expected to continue at a rapid rate, and the application of these improvements to specific problems will undoubtedly provide chemists and engineers with a wealth of information previously unobtainable.

Table 3—Summary of Wax Analysis by the Mass Spectrometer

	Composite of Eleven Fractions	Direct Analysis
Normal paraffins	98.59	100
Iso paraffins	0.42	0 ± 0.5
Mol. wt. 294	1.15	0 ± 0.4
Calc'd. mol. wt.	280.9	280.4
Measured mol. wt. (boiling point)	274	

Table 4—Analysis of Alkyl Benzene Blends by the Mass Spectrometer

Component	Approximate B.P.—° C.	Vol. % Known	Vol. % M.S.	Wt. % Known	Wt. % M.S.
Butyl benzene	180	10	10	14	14
Amyl benzene	190	2	3	2	2
Hexyl benzene		35	33	28	27
Heptyl benzene		3	3	2	2
Octyl benzene		1	1	1	1
Nonyl benzene		49	50	53	57
Total		100	100	100	100

Table 5—Solvent Analysis by the Mass Spectrometer

Compound	B.P. ° C.	Wt. % Known	Wt. % M.S.	Wt. % Known	Wt. % M.S.	Wt. % Known	Wt. % M.S.
Methyl ethyl ketone	79.6	7.8	6.6	7.9	5.6	60.7	57.2
Benzene	80.1	2.6	2.3	2.7	2.4	12.0	12.0
Toluene	110.6	68.0	71.6	68.9	69.9	35.0	39.4
Paraffinic hydrocarbons	100	1.0	1.4	1.0	1.9	0.6	0.6
Phenol	181.4	20.6	18.1			8.2	7.7
Nitrobenzene	210.9			19.5	20.2	3.5	3.0

Table 6—Analysis of Phenols by the Mass Spectrometer

Compound	B.P. ° C.	Vol. % Blend Known	Vol. % Blend M.S.	Vol. % Unknown M.S.
Phenol	181.4			10.4
Cresols	200	80	81	38.6
Mol. wt. 122	220	0	0	40.4
Mol. wt. 136	228	0	0	9.4
Mol. wt. 150	237	0	0	1.0
Mol. wt. 164	266	20	19	0.2
Total		100	100	100.0

Table 7—Relative Ionization of Maleic and Succinic Acids and Anhydrides

m/e	Maleic Acid	Maleic Anhydride	Succinic Acid	Succinic Anhydride
17	not scanned	0.41	154	2.88
18	150	0.47	568	9.09
24	8.60	3.00	4.64	4.05
25	31.9	35.2	21.8	19.2
26	100	182	115	97.8
27	9.80	9.01	88.1	84.2
28	18.7	12.2	440	437
29	7.43	6.76	23.0	21.1
30	0.22	0.14	4.06	0.48
36	2.75	2.80	1.71	1.40
37	3.06	3.08	2.58	2.71
38	0.29	0.32	1.51	1.34
39	0.17	0.05	0.87	0.45
40	1.40	1.42	0.96	0.88
41	6.75	7.20	4.33	3.62
42	1.59	1.34	13.8	13.7
43	0.26	0.07	1.51	0.86
44	7.20	6.50	12.9	6.34
45	1.41	1.24	2.74	2.15
52	2.92	3.00	1.35	1.12
53	11.7	11.6	4.84	3.95
54	100	100	0.79	1.57
55	3.56	3.30	7.02	6.08
56	2.54	0.32	100	100
57	0.34	0.10	2.45	3.42
69	0.59	0.32	0	0
70	0.10	0.06	0	0
98	18.4	23.5		
100			0	0
Sensitivity of Base Peak	not measured	10	not measured	not measured
Sensitivity of n-butane at mass 58		8.56		

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12. Young, W. S., *Nat'l. Petroleum News*, March 6, 1946.

It took 60 years to save three months

on Socony's new cat-cracker*

The cat-cracker, the most important processing unit in a refinery today, is usually built from the ground up like a skyscraper—one or two floors at a time. But Fluor has developed a new time-saving technique of designing the component parts so that they can be fabricated on the ground simultaneously and lifted into place, thereby making more efficient use of manpower and equipment. Construction crews work in perfect coordination on a production-line basis to effect substantial savings in construction costs, but above all *in time!*

Fluor designed and constructed the catalytic cracking unit shown here for Socony-Vacuum at Augusta, Kansas. It stands 268 feet high, equivalent to a 22-story building. Nine months and 13 days after foundation was poured, it went on stream for 15,000 barrels a day, three months earlier than could be normally expected if built by conventional methods under similar circumstances. This airlift TCC unit processes about 1½ million barrels of oil in three months; that's why getting it into operation in the shortest possible time was an all-important objective.

*Thermofor catalytic cracking unit built for Socony-Vacuum Oil Company at their Augusta, Kansas refinery

First, an experimental model was built to scale to check basic rigging design, to study actual erection problems, and to locate the most efficient work and storage areas before starting work in the field. The unit stood 5½ feet high.

October 26

Reinforced concrete was used to a height of 100 feet for fire protection. While the base was being poured (August 21, 1951), these concrete panels weighing 85 tons each were being cast on the ground slab.

Here's how it was done— from conception to *Completion*

December 22

In spite of sub-zero weather, the building marathon continues. The Reactor weighing 500 tons is being hoisted 180 feet into the air. It took less than an hour to complete this operation. The cracking process takes place in this unit.

January 4

This steel section, assembled on the ground and weighing 110 tons, was lifted 160 feet and lowered into place over the Reactor. It supports the Hot Catalyst Bin. This is one of 28 major lifts varying in weight from 60 to 325 tons.

March 5

After the last steel section was set, the Separator Surge Drum (63 tons) is raised into place on top. This was the last lift to be made. Total height is now 268 feet, 22 stories high, and is one of the tallest structures in Kansas.

May 10

Operation testing completed and ready for start up, 9 months and 13 days after foundation was finished. This cat-cracker is capable of processing 630,000 gallons of oil every day. Fluor has four more similar units under way.

For 60 years Fluor has been building for industry and is among the leaders in plant construction for the oil, gasoline, chemical and power industries in and out of the continental United States. If time-saving is your concern, take time to contact your nearest Fluor district office for details. Write for Bulletin CC-2521 describing Fluor activity in the construction of Fluid and Thermofor cat-crackers.

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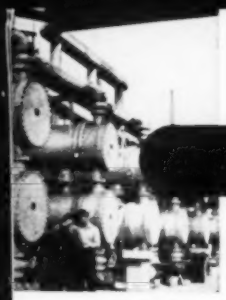

How to Stop Piston Pump Vibration

UNWANTED vibration in the discharge piping on a pair of positive displacement, piston-type pumps at Ohio Oil Co.'s Robinson, Ill., refinery has been overcome by using a series of simple, shop-made "pulsation dampeners." They have been installed in the piping system on poly unit charge pumps, as shown in the sketch in Fig. 1. The unit shown at *A* in Fig. 1 serves to help in the control of flow rate through the "hot" side of the double discharge line from the pumps by venting to a diaphragm motor-operated valve. The one shown at *B* vents to a relief valve (not shown), and in the unit at *C* no vent at all is necessary.

A typical dampener is shown in detail in Fig. 2. Similar to most devices of this type, it provides a vapor space in a small chamber which "cushions" the effect of pump pulsations. A steam jacket surrounding the chamber keeps the liquid which may enter it in the vapor phase.

The device is easily built from 4-in. pipe for chamber proper, and 3-in. pipe and a 3 x 4-in. swage nipple for connecting it to the main piping. The jacket was assembled from 6-in. pipe and cap, with $\frac{3}{4}$-in. couplings for the steam connections. The completed assembly is covered with insulation after being installed.

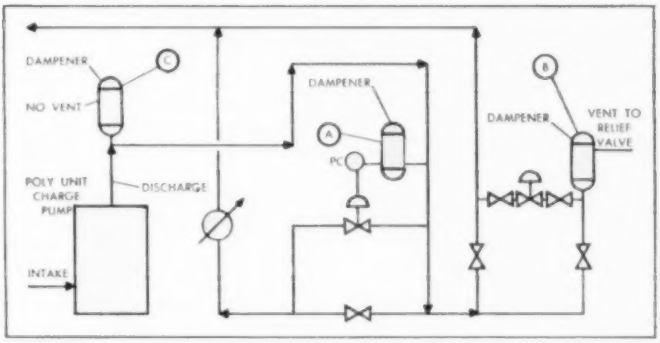

FIG. 1—Arrangement for use of pulsation dampeners in poly unit pump piping

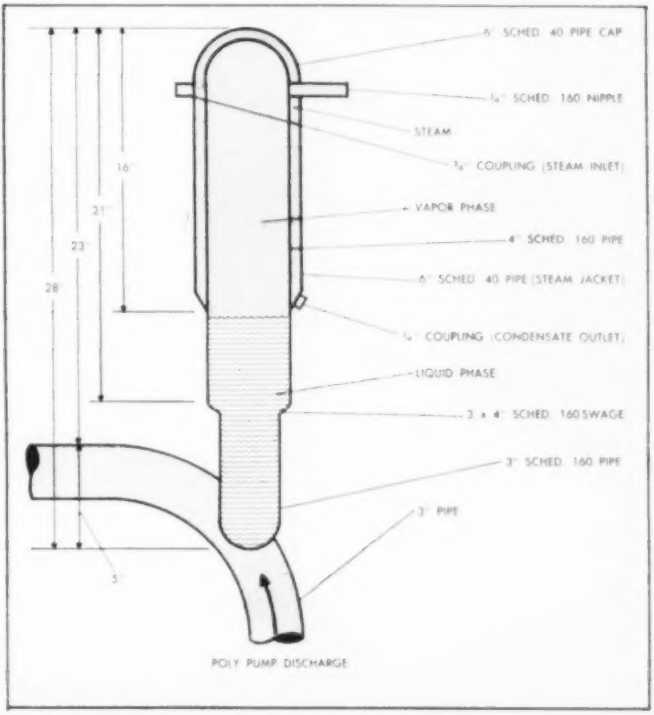

FIG. 2—Details of the pulsation dampener

Air Trap Speeds Unloading Of Tank Cars, Trucks

PROBLEMS in unloading tank cars or tank trucks of volatile hydrocarbons can be overcome by equipment developed and put into service by the gasoline department of Phillips Petroleum Co.

The apparatus includes an air trap which makes it impossible for the unloading pump to "gas off" or to become filled with gas so the pump and motor would run wild. It reduces the potential hazard of fire and is said to speed up the unloading.

As illustrated in the sketch that follows, a vessel or air trap *A*, connected to a header *B*, is in turn connected to the outlet connection of a number of tank cars or tank truck compartment outlets. The hydrocarbon being unloaded thus flows by gravity from header *B* into trap *A*.

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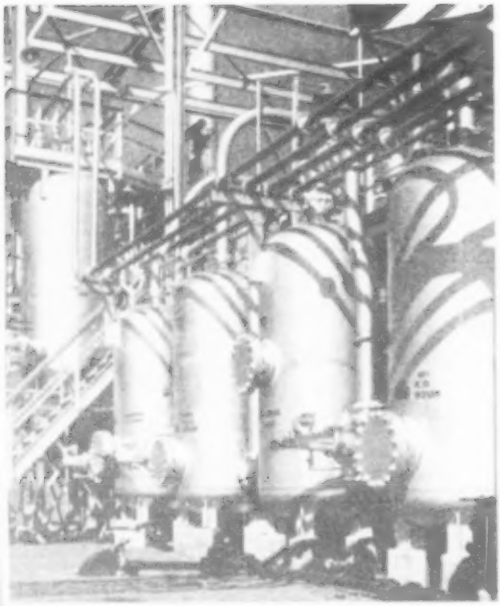

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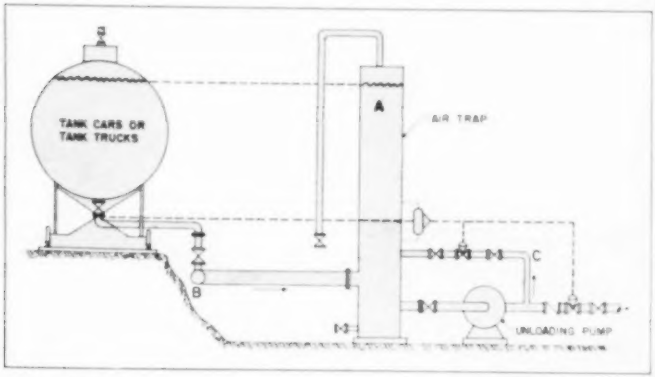

AIR-TRAPPING VESSEL makes tank car or truck unloading safer and easier

The unloading pump is connected into the bottom of vessel *A*, discharging through a check valve, motor valve, and block valve into storage. A by-pass line *C* discharges back into vessel *A* from the pump outlet line.

A level-control on vessel *A* controls both the by-pass and the pump discharge motor valves. When the level is high, the by-pass valve is closed and the discharge valve is open. When one tank car or compartment becomes empty, the level control automatically starts opening the by-pass valve and closing the discharge valve, until all cars or compartments are empty. Then the by-pass valve is wide open and the discharge valve is completely closed. In this way, the apparatus allows the completion of an unloading operation without "gassing off" the pump.

The above item is based on a prize-winning idea from the "Operating Kinks" competition at the Panhandle-Plains regional meeting of the Natural Gasoline Association of America in Amarillo, Texas, November 29, 1951. It was submitted by A. L. Hickerson, district engineer, gasoline department, Phillips Petroleum Co., Phillips, Texas.

How to Walk On Insulation

REACTOR INSULATION PROTECTED against damage by walking

THERMAL insulation is designed primarily to cut heat losses. It's no particular secret that it isn't much of a walking surface. To maintain top efficiency and appearance, it is wise to isolate insulated surfaces from accidental damage by employes. In the picture above, skid-proof metal plates protect insulation around the center and hatch of a reactor in a chemical plant. Formerly, workmen had to brace their feet against the insulation itself to remove the hatch cover. The additional cost of the metal plates was small compared to savings obtained through lower maintenance. The reactor, which operates at 550° F., is covered with 3-in. thick mineral wool blankets finished with insulating cement.—*Industrial Mineral Wool Institute*

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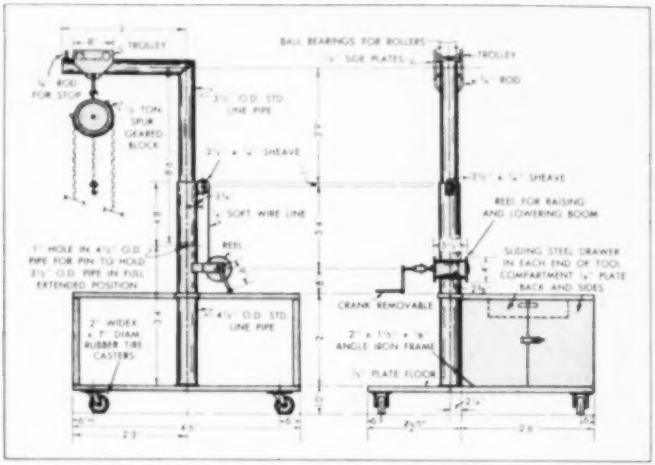
Combination Crane, Bench, Wagon for Engine Overhauls

A COMBINATION portable crane, work bench, and tool wagon has proved to be a very efficient labor-saving device for maintenance on electric generator drive engines at Skelly Oil Co., Skellytown, Texas. It has been particularly effective and useful for removing cylinder heads, cylinders, and pistons from some Ingersoll-Rand PVG 6 and 8 cylinder types which are situated side-by-side and therefore prevent the use of overhead traveling cranes.

The equipment is illustrated in the accompanying drawing. It can be built by any good welder in about 20 hrs. Skelly figures it paid for itself on its first overhaul job. Most of the details of construction are readily obtainable from the sketch and need no further elaboration.

The boom lowers to permit passage under piping and other obstructions. It can then be raised to lift engine parts with sufficient clearance. Parts can then be swung around as much as 180 accurate degrees or more and lowered to the floor for cleaning and repairing. The same procedure applies to re-assembling an engine. The material-handling unit can be rolled easily to any desired place around the engine by two men. The top deck is very handy to stand on while dismantling or re-assembling. Inside is a large tool compartment with doors at each end as well as sliding drawers at each end, providing adequate storage space for all the usual tools required for overhaul work.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BALL BEARINGS FOR ROLLERS
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TROLLEY
½" ROD FOR STOP
½ TON SPUR GEARED BLOCK
2½" O.D. STD. LINE PIPE
½" ROD
2½" x ¼" SHEAVE
2½" x ¼" SHEAVE
SOFT WIRE LINE
REEL FOR RAISING AND LOWERING BOOM
1" HOLE IN 4½" O.D. PIPE FOR PIN TO HOLD 3½" O.D. PIPE IN FULL EXTENDED POSITION
REEL
SLIDING STEEL DRAWER IN EACH END OF TOOL COMPARTMENT ¼" PLATE BACK AND SIDES
CRANK REMOVABLE
2" WIDE x 7" DIAM RUBBER TIRE CASTERS
4½" O.D. STD. LINE PIPE
2" x 1½" x ⅛" ANGLE IRON FRAME
¼" PLATE FLOOR

THREE TOOLS IN ONE simplify overhauls on large engines

The preceding item is based on a prize-winning idea from the "Operating Kinks" competition at the Pushabile-Plants regional meeting of the National Gasoline Association of America in Amarillo, Texas, November 29-1951. It was submitted by G. I. Harkrader, Skelly Oil Co., Skellytown, Texas.

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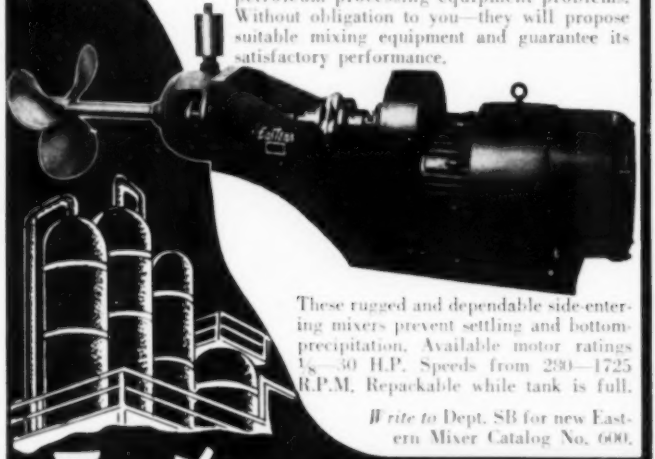

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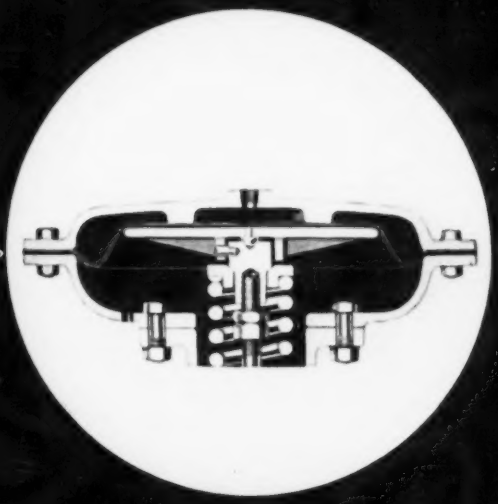

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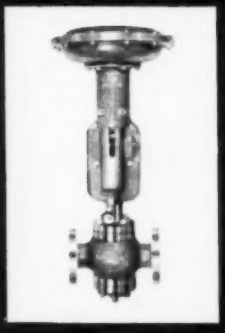

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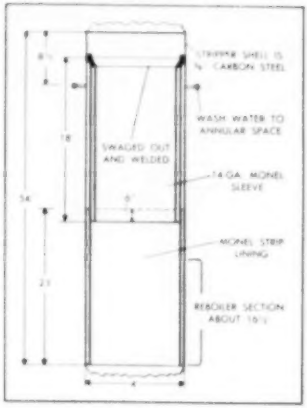
Quick Economical Method for Re-Lining Process Vessels

THERE'S more than one way to skin a cat, so there must be more than one way to line a vessel. Thus reasoned the maintenance department at the Cheyenne, Wyo., refinery of Frontier Refining Co.

The vessel involved was a caustic stripper at the Unisol treating unit. It is 4 ft. in diameter by 54 ft. in height, with a shell of ⅝ in. carbon steel. The bottom 16½ ft. of the column contained the reboiler section. The inside walls in this section had been strip-lined earlier with Monel to a height of about 23 ft.

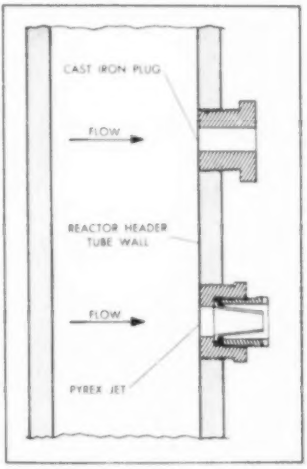
However, the top section, above the reboiler where the caustic is relatively cool, was also found to be showing corrosion effects. It was decided therefore to line the upper walls as well. A sleeve, or cylinder, was made of sheet Monel, about 14-gauge, in a diameter approximately 1 in. less than that of the column I.D., and 18 ft. long. This sleeve was lowered into the column from the top, telescoping into the previously-installed strip liner about 6 in. The top end of the sleeve was then swaged out to contact the column wall and was welded at that point only. A ring manifold was then placed around the tower about 8½ ft. down from the top, to introduce wash water to the annular space between the sleeve and the wall. See sketch.



ONE-PIECE CYLINDRICAL LINER for caustic tower saved time by eliminating strip-lining technique

The sleeve has been in service for two years with no signs of further corrosion developing in the tower. The labor savings for installation were very great. It took about 16 hrs. for a small crew to insert and weld it in place. By comparison, the bottom strip lining required a larger crew of men five full 24-hr. working days to install. In addition an appreciable saving was realized in weld metal.

Iron Beats Glass for Jets In Alkylation Reactor



LESS MAINTENANCE TROUBLE in alkylation unit header resulted from cast iron plug (top) than from glass nozzle (bottom)

PYREX glass jets in the reactor headers of the sulfuric acid alkylation unit at Utah Oil Refining Co.'s Salt Lake City refinery were giving trouble because they would break up and plug the outlet.

An easy solution, as worked out by Utoco engineers, was to use some 2-in. cast iron pipe plugs as substitute jets, as shown in the accompanying sketch. The fitting on the header in which the pyrex nozzle had been installed was removed, and a 2-in. hole was tapped at the same location. The pipe plug, with a small hole drilled out to the same size opening as that in the pyrex jet, was then screwed into place. Ordinary pipe threading compound was found satisfactory as a seal.

The new cap has resulted in the decrease of acid consumption and improvement in alkylate quality. Part of this is due to the fact that the pressure drop across the header now remains the same throughout the run.

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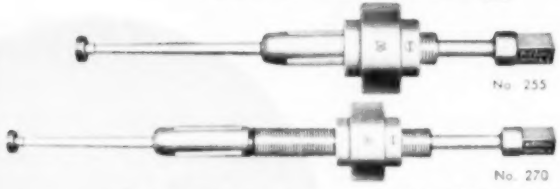

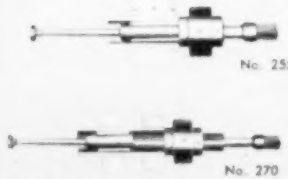

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Chart for Sulfates in Cooling Tower Water

By MILTON R. BEYCHOK*

IT OFTEN becomes desirable to calculate the sulfate content that would develop theoretically in a cooling tower water. The sulfate content would result from water concentration in the tower as well as sulfuric acid additions to the water for control of pH.

The theoretical sulfate content, when compared to an actually determined content, can furnish a picture of the sulfate scale control needed. Calculation of the normal build-up of sulfates is as follows:

SO_4 from concentration =
(SO_4 in raw water) (cycles of concentration)

The sulfates resulting from sulfuric acid addition are:

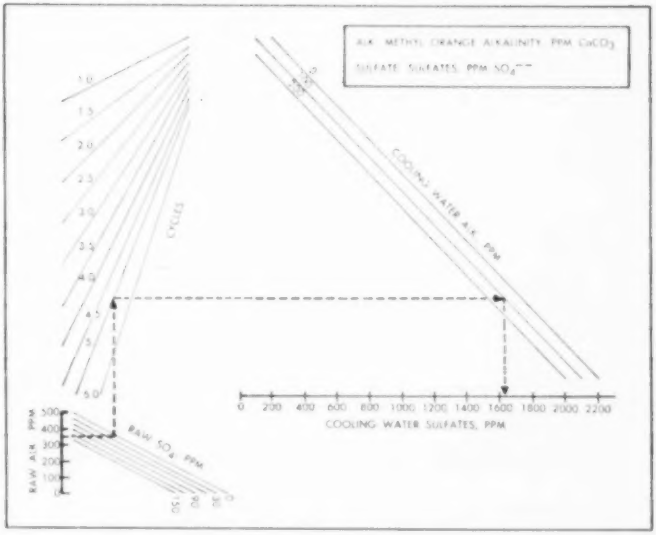
SO_4 from acid =
(alkalinity in rawwater) (cycles) (cooling water alk) 0.96

The alignment chart at the right is for the rapid calculation and addition of the above two equations. The use of the chart is illustrated by the example indicated by the dotted lines.

If the calculated sulfate content from the alignment chart is higher than an actually determined content, then sulfate scale is probably being deposited. If the calculated content is lower than the actual content, then old sulfate deposition is being re-dissolved, or acid is being over-fed.

The proper scale units are as follows: alkalinity methyl orange alkalinity, ppm. $CaCO_3$; sulfate ppm. SO_4. Cycles of concentration is usually determined by the chloride ratio of concentrated water to raw water.

* Mr. Beychok is chief chemist, Rothschild Oil Co., Santa Fe Springs, Calif., and a previous contributor to these columns.


ALK. METHYL ORANGE ALKALINITY, PPM $CaCO_3$
SULFATE, SULFATES, PPM SO_4^{--}
CYCLES
COOLING WATER ALK. PPM
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200
COOLING WATER SULFATES, PPM
RAW ALK. PPM
RAW SO_4 PPM

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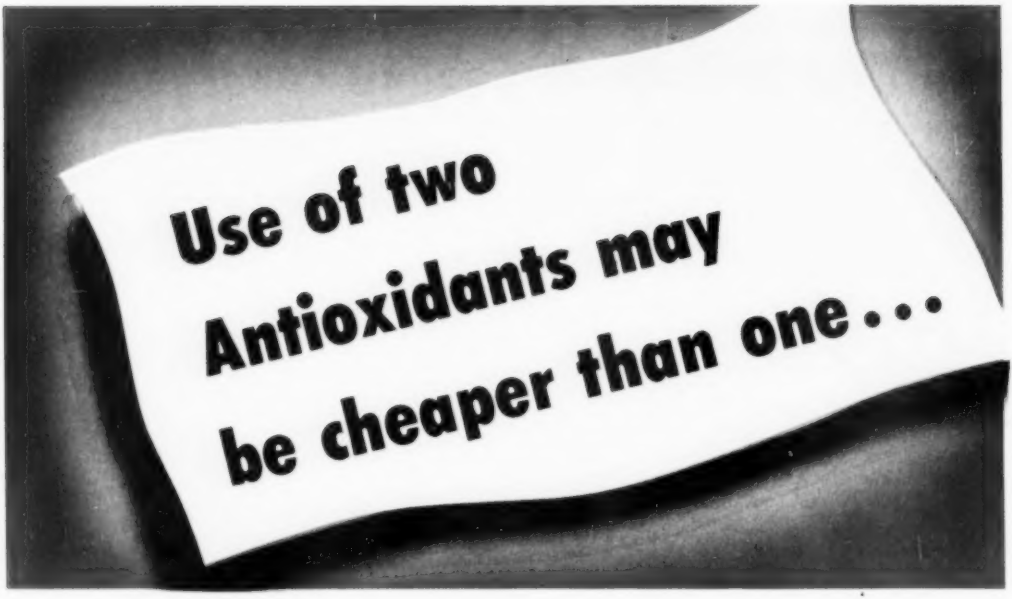
(To obtain more data on advertised products see page 248)



Du Pont District Laboratories may save you money by recommending combinations of antioxidants for certain gasoline stocks

Antioxidant treating results vary with different gasolines. Recognizing this, Du Pont makes two types of antioxidants—Nos. 5 and 22. The question then arises, which is most effective in your particular stocks—depending on your current induction period specifications. Or, might a combination of the two work out best? For an answer to such queries, the nearest Du Pont Petroleum Chemicals Division district laboratory will be glad to evaluate your stocks for antioxidant response. Here is the result of one such investigation . . .

One refiner's gasoline responded more favorably to Du Pont Antioxidant No. 5. Nevertheless, due to an abnormal caustic carry-over in the treating process, Du Pont Antioxidant No. 22 was considered mandatory in this case.

After studying this refiner's treating process and gasoline stocks, the Du Pont district laboratory recommended as a first step that 2 lbs. of Antioxidant No. 22 per 1000 barrels be added as the cracked stream left the cracking unit. This served to protect the stocks prior to and during sweetening.

After doctor treating, the gasoline was further inhibited to a 360 minute induction period with Du Pont Antioxidant No. 5 during the final blending process. . . *A six-month trial period showed that this method provided a substantial saving for the refiner.*

If you have any antioxidant treating problems, if you have recently changed stocks, or, if you have merely changed your induction period level, the nearest Du Pont district laboratory will be glad to help you determine the most effective means of using antioxidants.

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(To obtain more data on advertised products see page 218)

PROCESSING PATENTS

New Developments in Processes and Products

By PETER J. GAYLOR
Editor, "The Technical Survey"

New Texaco Naphtha Treating Process Gives Nearly 100% Mercaptan Removal

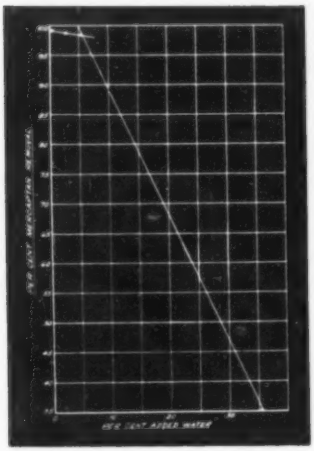


FIG. 1—Efficiency of mercaptan removal using 0.45 molal solution of KOH in anhydrous monoethanolamine is greatly effected by amount of water present. Critical value is 5.6%

MERCAPTANS, of course, are thiols, and most sour naphthas generally contain alkanethiols. In its U. S. patent 2,578,602, Texaco Development Corp. discloses that a practically 100% removal of mercaptans can be effected from naphthas, without disulfide formation, by reacting them with alkanolamines in presence of alkali metal hydroxide. This reaction does not appear to be a simple one, but more nearly represents the following:

$$RSH + MOH + HOR'NH \rightarrow RSM + HOR'NH\,OH$$

In practice, the hydrocarbon is treated with a substantially anhydrous alkanolamine solution of an alkali metal hydroxide such as sodium or potassium hydroxide. The solid caustic is dissolved in the alkanolamine in slight excess over the theoretical amount required.

An alkanolamine is used which is substantially insoluble in the hydrocarbon. Monoethanolamine and monoisopropanolamine, for example, are highly effective for this purpose at normal temperatures. Diethanolamine and triethanolamine, due to their viscosities, are best reagents when used at around 120° F.

As can be seen from Fig. 1, it is essential that the caustic-alkanolamine solution and the treated hydrocarbon be substantially anhydrous. Once the amount of water exceeds the critical value of 5.6% (which appears to be the transition from the anhydrous to the aqueous zones), the mercaptan removal decreases very rapidly. Accordingly, it is proposed that a prior treatment be made with aqueous caustic. When higher mercaptans are present in a naphtha stock, some 60% of the mercaptans is about as much as can be removed by the aqueous caustic regardless of the efficiency of contacting or of the amount of excess caustic employed. This prior treatment with aqueous caustic also would remove hydrogen sulfide, carbon dioxide, phenols, thiophenols, etc., as well as water, although not completely with respect to the latter.

The patent brings out the fact that the aqueous alkanolamine-alkali metal hydroxide solution resulting from the final treat can be recycled after dehydration by azeotropic distillation with toluol or by other means, while the mercaptans therein may be steamed out in a prior operation or oxidized.

It is pointed out that typical prior art practice for removing mercaptans from naphtha requires some 4 lbs. of caustic per barrel of naphtha treated and such treatment will not completely remove the mercaptans except, possibly, where only mercaptans lower than amyl are present. When resorting to sodium plumbite for sweetening, an additional 4 lbs. of caustic and ½ lb. of litharge per barrel are employed and, in this case, the difficultly removable sulfur compounds are not removed but only are changed to other forms (disulfides). By the patented process, a West Texas naphtha containing 0.02 gram mol of mercaptans per liter or 0.227 lb. mercaptan sulfur per barrel, required 0.56 lb. NaOH per barrel of naphtha for the 40% caustic pretreat and a further 0.23 lb. caustic with 1.7 lbs. ethanolamine per barrel for complete mercaptan removal, and without leaving disulfide compounds in the naphtha.

Heavy Alkylate Fractions Are Toxic to Insects

ALKYLATE hydrocarbons consist mainly of branched chain paraffins which are substantially non-toxic to animals and plants, and cause relatively little swelling of natural or synthetic rubbers which they may happen to contact. This is in decided contrast to other hydrocarbons, such as aromatics, for example.

Yet, it has been shown in a recent Phillips Petroleum Co. patent (U.S. 2,575,098) that certain fractions of heavy alkylate possess a synergistic effect on the toxicity of insecticides. This is readily observed from Fig. 2 which depicts a toxicity curve for various alkylate fractions containing a fixed amount of standard insecticide (0.1% pyrethrins). One fraction is shown to be particularly potent in this respect, and its characteristics have been listed in the patent as follows:

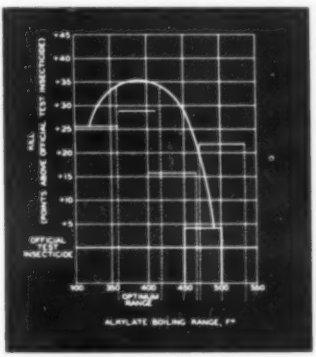
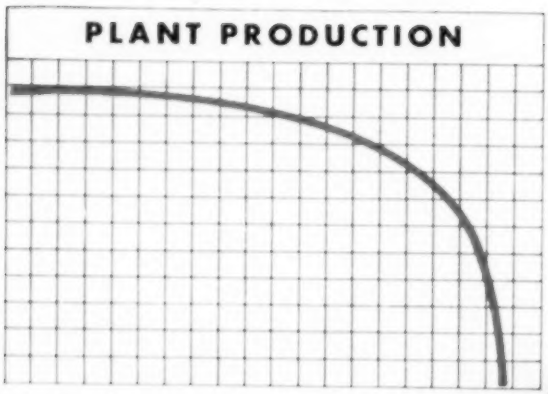


FIG. 2—Effect of boiling range of alkylate fraction on insecticide kill

Properties	Test Results
Distillation (760 mm.):	
IBP, ° F.	366
10%	372
20%	373
50%	375
70%	377
90%	384
EP	389
E.P.	403
Gravity at 60° F., ° API	53.5
Specific Gravity at 60/60° F.	0.7649
Refractive Index at 20° C.	1.4242
Flash Point (TOC), ° F.	143
Fire, ° F.	160
Color, Saybolt	+26
Sulfur Content, wt. %	0.0011
Corrosion (3 hrs. at 122° F.)	Passing
Doctor Test	Negative



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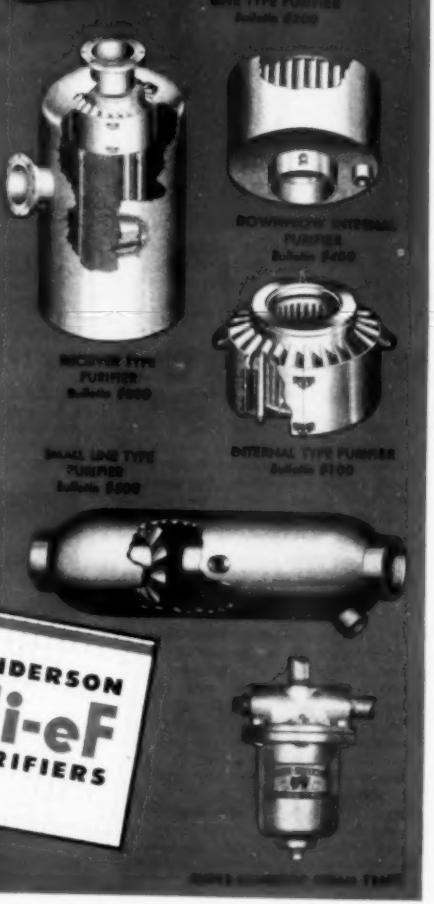

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Kauri Butanol Number	25.4[1]
Dimethyl Sulfate Value, %	2[2]
Bromine Number	1.2
Viscosity, at 100° F., Centistokes	1.61
Comparative Spot Dry Time	27 Min.
Residual Odor Test	None
Odor	Neutral[2]

[1] H. A. Gardner, "Physical and Chemical Examination of Paint, Varnish Lacquers and Colors," 6 ed., 1933.
[2] No naphtha or kerosine odor.

Mercaptan Removal

ACCORDING to a Canadian patent issued to The Pure Oil Co., mercaptans can be removed effectively from oils by extraction with 5% caustic soda containing at least 10% sodium naphthenates, together with a solvent for the naphthenates, such as sodium phenolate or cresylates, and 1-20% of a glycol such as triethylene glycol, propylene glycol or butylene glycol (Can. 469,397).

Shell Development Co. already has covered the use of propylene glycol, butylene glycol, and polyglycols as solutizers (U. S. 2,152,166, 2,183,801 and 2,186,398).

Fuel Oil Improver

AN anti-clogging concentrate adapted to be added to a hydrocarbon distillate fuel normally susceptible to clogging, consists of 15% by weight of oil soluble sulfonates of acids having a molecular weight of 475-650 (derived from a naphthenic petroleum stock), 10% of a barium salt of alkyl phenol disulfide, and 75% of a 50-50 blend of catalytically cracked light gas oil and straight run acid treated gas oil (U. S. 2,527,987—Shell Development Co.).

Patents Issued in December

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for December 4, 11, 18 and 25, Vol. 653, Nos. 1-4.

Catalysts

Re 23,438 (Shell Development Co.) Preparation of silica-alumina cracking catalyst.
2,577,504 (Phillips Petroleum Co.) Preparation of a supported aluminum-halide-carbon catalyst.
2,577,631 (Standard Oil Development Co.) Manufacture of microspheroidal gel particles.
2,579,123 (Gulf Research & Development Co.) Reactivation of silica-alumina catalysts by silica addition.
2,579,133 (Gulf Research & Development Co.) Reactivating a silica-alumina catalyst by impregnation with boria.
2,579,678 (Sinclair Refining Co.) Catalyst regeneration.
2,580,004 (Standard Oil Development Co.) Removal of iron from regenerated cracking catalyst fines.

Hydrocarbon Synthesis

2,578,931 (Hydrocarbon Research, Inc.) Synthesis of hydrocarbons in the presence of a fluid phase catalyst.
2,577,634 (Standard Oil Development Co.) Recovery of hydrocarbons from tail gases in synthesis streams.
2,577,730 (Hydrocarbon Research, Inc.) Iron oxide reduction with CO and hydrogen.
2,578,144 (The Texas Co.) Catalyst for the reaction of carbon monoxide and hydrogen with unsaturated compounds.
2,578,475 (Gulf Research & Development Co.) Production of gas comprising hydrogen and carbon monoxide.
2,578,662 (Gulf Research & Development Co.) Process of synthesizing hydrocarbons.
2,579,828 (The M. W. Kellogg Co.) Synthesis of organic compounds.
2,579,843 (The M. W. Kellogg Co.) Method for the manufacture of synthesis gas.
2,580,093 (Standard Oil Development Co.) Production of an iron catalyst for hydrocarbon synthesis.
2,580,116 (The M. W. Kellogg Co.) Synthesis of organic compounds.

Chemicals

2,577,917 (The Texas Co.) Preparation of heavy hydrocarbons of hydrogen isotopes.
2,577,955 (Ohio Service Oil Co.) Oxidizing normally gaseous hydrocarbons, employing partial oxidation.
2,577,191 (Socony-Vacuum Oil Co.) Formaldimines and their reaction products.
2,577,205 (Reppe, Magin) Production of ketonic bodies from olefin, CO and water.
2,577,566 (Socony-Vacuum Oil Co.) 3-Thienyl thioethers.
2,577,840 (Standard Oil Development Co.) Method for analyzing hydrocarbons containing diolefins.
2,577,877 (Phillips Petroleum Co.) Solution polymerization.
2,577,796 (Shell Development Co.) Unsaturated esters of phosphinous acids and polymers thereof.

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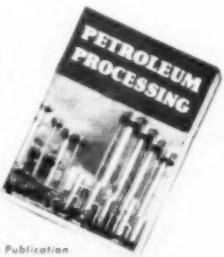

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Refining

2,577,202 (Standard Oil Co.) Process for separating organic compounds with urea.

2,577,611 (Shell Development Co.) Fractional distillation process.

2,577,691 (Shell Development Co.) Fractionation process.

2,577,700 (Phillips Petroleum Co.) Recovery of unsaturated oil from used HF catalyst.

2,577,722 (The Standard Oil Co. (Ohio)) Hydrodesulfurization of sulfur-containing hydrocarbon fractions.

2,577,724 (The Standard Oil Co. (Ohio)) Refining petroleum fractions with hydrocarbons with a solid impregnated charcoal.

2,578,054 (Shell Development Co.) Extractive crystallization using a employing urea.

2,578,310 (The Atlantic Refining Co.) Solvent fractionation of wax-containing mixtures.

2,578,402 (Texaco Development Corp.) Dewaxing hydrocarbon and other organic liquids.

2,578,403 (K. A. Fischer) Method of dewaxing petroleum products with monobromo-monochloro-methane.

2,578,424 (California Research Corp.) Fractional crystallization process.

2,578,681 (The Lummus Co.) Separation of wax by filtration with flue gas chilling.

2,578,867 (Shell Development Co.) Extraction process.

2,580,129 (The Rotrite Associates) Apparatus for separating heavy liquid fuels.

2,580,376 (The Lummus Co.) Flue gas chilling.

Specialties

2,577,218 (Shell Development Co.) Emulsion of concentrate.

2,577,219 (Shell Development Co.) Corrosion inhibition with a mixture of inhibitors of differing solubility.

2,577,643 (Standard Oil Development Co.) Wax compositions containing heterocyclic carboxylate.

2,577,436 (Standard Oil Development Co.) Polyethylene wax compositions.

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Processing Patents

2,578,861 (The Patent and Licensing Corp.) Asphalt-base laminating adhesive.
2,579,632 (Asphalt Specialties Co.) Pumpable powdered asphalt suspension.
2,580,025 (Standard Oil Development Co.) Bituminous antifouling pipe line enamel.
2,580,085 (Standard Oil Development Co.) Method of improving flow properties of asphalt with alpha-nitronaphthalene.
2,580,086 (Standard Oil Development Co.) Rust inhibiting composition containing pentaerythritol mono oleate and propylene diamine.
2,580,048 (Standard Oil Development Co.) Fungicidal emulsion comprising a copper salt of an alkylated phenoxy acetic acid.
2,580,288 (Standard Oil Co.) Anticorrosion compositions containing dialkoxy diaminosilane.

Conversions

2,577,632 (Standard Oil Development Co.) Supplying plasticizable carbonaceous solids into a gasification zone.
2,577,788 (Standard Oil Development Co.) Concurrent dealkylation of aromatic hydrocarbons and dehydrogenation of naphthenic hydrocarbons.
2,578,377 (Sinclair Refining Co.) Catalytic conversion of hydrocarbons with finely divided catalysts utilizing sonic vibrations.
2,578,701 (Houdry Process Corp.) Reforming of hydrocarbons with dehydrogenation catalysts.
2,579,433 (California Research Corp.) Process for polymerizing olefins with phosphoric acid film catalyst.
2,579,576 (Great Lakes Carbon Corp.) Cracking with acid-treated clay catalyst.
2,579,669 (Phillips Petroleum Co.) Catalytic HF isomerization of acetylenic hydrocarbons.

Lubricants

2,577,636 (Sun Oil Co.) Sulfurization of lard oil.
2,577,706 (California Research Corp.) High melting-high water-resistant grease.
2,577,719 (California Research Corp.) Lubricating compositions containing dicarboalkoxy-dihepta(tetra) selenides.
2,578,695 (M. W. Freeman) Lubricant containing a reaction product of water-soluble sulfonic acids and phosphorus sulfide.
2,578,851 (Gulf Oil Corp.) Lubricating greases.
2,578,865 (The Standard Oil Co.-Ohio) Machining fluid containing sulfur motor polymer.
2,579,037 (C. C. Wakefield & Co. Ltd.) Lubricating composition containing salt of dithiophosphoric acid.
2,579,038 (C. C. Wakefield & Co. Ltd.) Lubricant composition containing tin sulfonate and chromium salt of octyl cresyl dithiophosphoric acid.
2,580,005 (Standard Oil Development Co.) Sulfur-phosphorus extreme pressure lubricating compositions.
2,580,038 (Standard Oil Development Co.) Mineral oil containing resinified esters of salicylic acid.
2,580,274 (Shell Development Co.) Heavy duty lubricant.

Fuels

2,578,432-3 (Gasoline Research Industrial & Commercial Inc.) Process for producing apparent solidification of liquid hydrocarbons.
2,579,397-8 (Standard Oil Development Co.) Method for converting coal using fluidized solids technique.
2,579,692 (Standard Oil Development Co.) Gasoline fuel containing dimethyl carbinol and solvent oil.
2,579,890 (Shell Development Co.) Nonclogging distillate fuel oil containing dioctyl sodium succinate, alkyl phenol disulfide barium salt, and diethylene glycol monobutyl ether.
2,580,015 (Hercules Powder Co.) Diesel fuel containing dialkylaryl(methyl) hydroperoxide.
2,580,243 (Ethyl Corp.) Process of deleading gasoline.

Miscellaneous

2,577,079 (Texaco Development Corp.) Separation of fatty oil from solid bleaching agents.
2,577,254 (Phillips Petroleum Co.) Removing carbon and carbonaceous deposits from heat exchanger equipment.
2,579,005 (P. Lambert) Installation for underground storage reservoirs for liquids nonmiscible with water.
2,579,215 (Shell Development Co.) Wide range liquid fuel burner and method for increasing adjustability range of whirl-type atomizing burners.

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When production depends so vitally on adequate handling of gas or air, you can't afford to take chances on the performance of your blowers or exhausters. It's better to be safe than sorry.

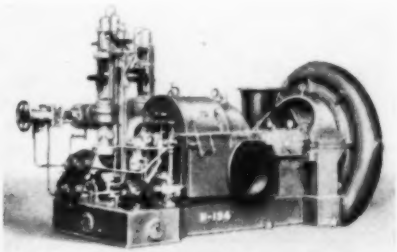
So, for new installations or replacements, we suggest that you evaluate the equipment by the above standards of comparison. This will help determine the unit that will be most effective, economical and reliable for your specific applications.

Be sure to include the R-C *dual-ability* line of both Centrifugal and Rotary Positive types. Remember, that only we offer you this *dual choice* —with unbiased recommendations from almost a century of experience. With capacities from 10 cfm to 100,000 cfm or higher at moderate pressures, R-C equipment has a long record of outstanding performance in industrial applications.

We'll gladly send detailed information for comparison—or supply engineering help if we can be of service.

ROOTS-CONNERSVILLE BLOWER CORPORATION
521 Texas Avenue, Connersville, Indiana

CENTRIFUGAL

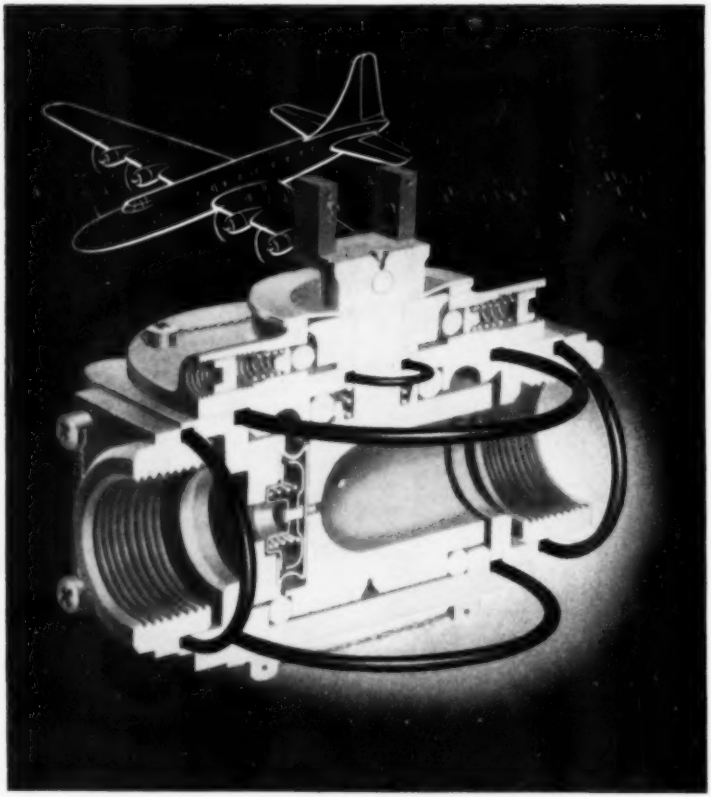


Type OIB Gas Exhauster. Capacity 19,000 cfm, driven by 332-hp steam turbine.

Reg. U. S. Pat. Off.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

(To obtain more data on advertised products see page 248)



Cutaway View of PARKER Aircraft Shutoff Valve Showing O-Rings

Leakproof Seals...Simple to use

WHEN YOU SPECIFY PARKER O-RINGS

THIS IS IT

Cross section drawing of O-ring in groove, sealing under pressure.

PARKER synthetic rubber O-rings provide perfect, leakproof sealing with economy of weight and space . . . without special complicated design . . . just a groove for the O-ring is needed. Economical in first cost, easy and simple to replace. For moving and non-moving applications.

PARKER is the one source for all standard O-rings to meet specifications covering fuel, hydraulic and engine oil services . . . and for special service O-rings of tested and approved compounds. Ask your PARKER O-ring Distributor for Catalog 5100, or write direct to The PARKER Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

Parker

O-RINGS

ARE STOCKED BY THESE AUTHORIZED DISTRIBUTORS

AKRON
B. W. Rogers Co.
850 So. High St.
Akron 9, Ohio

BOSTON
Irving B. Moore Corp.
65 High Street
Boston, Mass.

BUFFALO
Hercules Gasket & Rubber Co.
327 Washington St.
Buffalo 2, N. Y.

CHICAGO
Shields Rubber Co.
564 W. Randolph St.
Chicago 6, Ill.
Air Associates, Inc.
5300 W. 63rd St.
Chicago, Ill.

CLEVELAND
Cleveland Ball Bearing Co.
3665 Carnegie Ave.
Cleveland, Ohio
Neff-Perkins Co.
1360 West 9th St.
Cleveland 13, Ohio

DALLAS
Air Associates, Inc.
3200 Love Field Dr.
Dallas 9, Tex.

DETROIT
J. N. Fauver Co.
69 West Hancock St.
Detroit 1, Mich.

FORT WORTH
Adco Industries
1413 Electric Bldg.
Fort Worth 2, Tex.

INDIANAPOLIS
F. H. Langsenkamp Co.
229 E. South St.
Indianapolis, Ind.

LOS ANGELES
Aero Bolt & Screw Co., Inc.
1071 Arbor Vitae Ave.
Inglewood, Calif.
Synthetic Rubber Products Co.
1538 South Eastern Ave.
Los Angeles 22, Calif.

MIAMI
Air Associates, Inc.
International Airport
Miami, Fla.

MILWAUKEE
Allrubber Products & Supply Co.
612 South Second St.
Milwaukee 4, Wis.

MINNEAPOLIS
Van Dusen Aircraft Supplies, Inc.
2004 Lyndale Ave., South
Minneapolis 5, Minn.

NEW YORK
Durham Aircraft Service Co.
5615 Northern Blvd.
Woodside, N. Y.
Nielsen Hydraulic Equipment Co.
295 Lafayette St.
New York 12, N. Y.

PHILADELPHIA
Goodyear Supply Co.
1506 Latimer St.
Philadelphia, Pa.

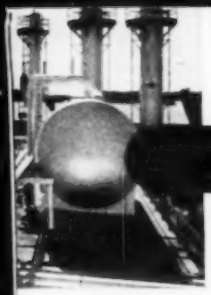
PITTSBURGH
Shields Rubber Co.
137 Water St.
Pittsburgh 22, Pa.

PORTLAND
Hydraulic Power Equipment Co.
2316 N. W. Savier St.
Portland 10, Ore.

ST. LOUIS
Metal Goods Corp.
5239 Brown Ave.
St. Louis 15, Mo.

WICHITA
Standard Products, Inc.
650 E. Gilbert
Wichita 11, Kan.

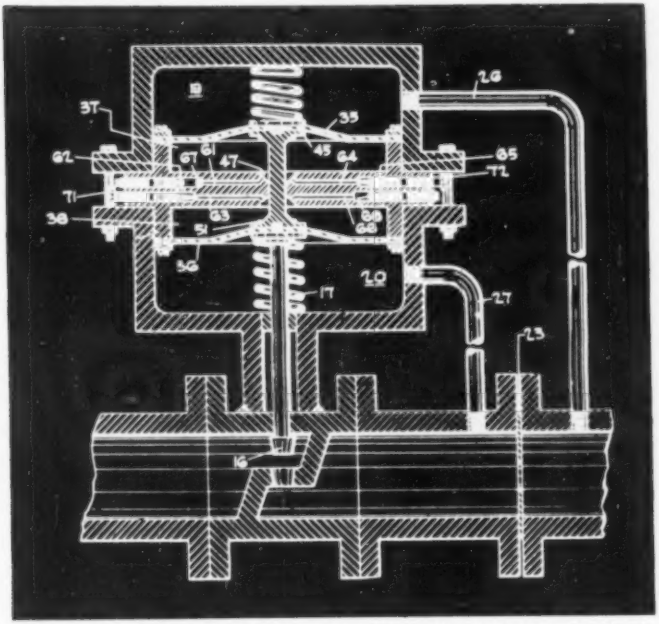
CANADA
Railway & Power Engineering Corp., Ltd.
3745 St. James St.
Montreal 30, Que.



EQUIPMENT PATENTS

Brief Reviews of New Inventions in Equipment

Adjustable Plug Valve Rate



NEEDLE VALVES 71 and 72 on inner ports of valve positioner permit rate control

AN adjustable rate damping device for differential pressure responsive, diaphragm-operated valves has been developed and described in a recent Shell Development Co. patent. It is said to be particularly applicable in pipe line operation, where service conditions may require a valve to be opened and closed at different rates.

Essentially a double-diaphragm design, the valve controller is illustrated in the accompanying sketch. Orifice plate 23 may be either upstream or downstream. In this example it is upstream. Pressure chamber 19 above upper diaphragm 35 in the device communicates through conduit 26 with the main flow line upstream of the orifice 23. A similar connection is made between pressure chamber 20 beneath diaphragm 36 and the downstream side of the orifice via line 27. In this case, spring 17 is considered omitted, and spring 17 keeps valve 16 normally open. Chambers 37 and 38, with the diaphragms 35 and 36, are in communication with each other through channels or ports 61, 62, 63, 64, 65, and 66. They are filled with a relatively non-compressible fluid such as an oil with reasonably constant viscosity at operating temperatures and a low freezing point.

In operation, if the upstream pressure increases, the diaphraghms are forced downward by the higher pressure in chamber 19 overcoming the force of spring 17. Simultaneously, fluid flows from chamber 37 through the various ports 61-66 into chamber 38. Also at the same time, the inner valve plate 45 ultimately seats on seat 47, closing port 61 and stopping fluid flow from chamber 37 to 38. This protects diaphragm 35 against a rupture from increased pressure in chamber 19. When line pressure drops, pressure in chamber 19 will decrease and the main valve 16 will open.

The rate of opening and closing of the main valve 16 depends upon the rate of transfer of fluid between chambers 37 and 38. It is closely controlled by precise adjustments of the settings on needle valves 71 and 72 in the inner ports and the check valves 67 and 68.

U. S. 2,579,334, issued December 18, 1951, to Norris Plank, assignor to the Shell Development Co.

Patents Issued in December

The following classified listing covers patents issued during the month of December, 1951, believed to be of interest or value to petroleum processing or handling operations.

Processing, general

2,576,040 (Foster Wheeler Corp.) Bubble cap.

2,577,674 (Shell Development Co.) Automatic distillation apparatus for laboratory analysis.

2,577,787 (Chicago Bridge & Iron Co.) Mixing and blending device for storage tanks.

2,577,808 (Standard Oil Development Co.) Polymerization reaction vessel.

2,578,096 (Eastman Kodak Co.) High vacuum fractionating distillation apparatus.

2,578,101 (The Pure Oil Co.) Differential pressure distilling apparatus and method.

2,578,581 (Gilbert & Barker Mfg. Co.) Bubble cap assembly.

2,578,928 (Hymon R. Dyer) Fractionating tower.

2,578,995 (Eastman Kodak Co.) Vacuum distillation apparatus.

2,579,291 (Stratford Engr. Corp.) Gas-liquid contactor.

2,580,016 (Standard Oil Development Co.) Apparatus and process for liquid-liquid extraction.

2,580,260 (The Lummus Co.) Bubble-cap hold-down device.

Catalytic Reactors

2,577,791 (Houdry Process Corp.) Catalytic conversion unit with gas separator.

2,578,472 (Phillips Petroleum Co.) Catalytic chamber of the stationary bed type.

Instruments

2,577,767 (Telemeter Corp.) Drive mechanism for storage tank gage, adjustable for liquids of different specific gravity.

2,577,768 (Hagan Corp.) Compensated specific gravity measuring device.

2,577,793 (Standard Oil Development Co.) Liquid level gage for tank cars.

2,577,829 (Jesse Oil Co.) Storage tank liquid level measuring device.

2,578,106 (James Y. Taylor) Equipment magnetic type liquid level gage for fluids or liquefied gases stored under pressure.

2,578,257 (Kent-Ited & Vickers Ltd., London, England) Movement transmitting system of the magnetic type.

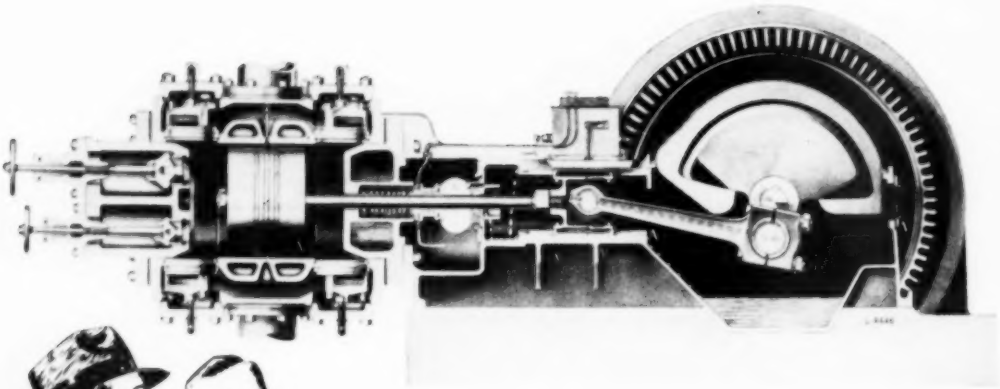
2,578,363 (Taylor Instrument Cos.) Glass thermometer compensated for error due to aging of the glass.

2,578,364 (Shell Development Co.) Adjustable rate differential pressure responsive device.

2,578,719 (Buffalo-Eclipse Corp.) High pressure liquid level gage.

2,578,825 (Phillips Petroleum Co.) Gas analyzer.

2,578,833-4 (Combustion Control Corp.) Flame failure control systems.



Cutaway of typical Worthington horizontal compressor which has many advantages for loads over 450 tons.

Why a Horizontal Compressor for the Heavier Refrigeration Loads?

Worthington, unlike other refrigeration compressor manufacturers, makes *all three* types of ammonia compressors—vertical, V-type, horizontal—to cover the complete range of customer needs.

For the *heavier* loads, Worthington offers a complete range of *horizontal* compressors. Why? What are the advantages of horizontals for heavier loads?

1. More work done. Only the horizontal is double-acting—that is, the piston is working on both strokes.

2. Two stages of compression in one machine. For low-temperature work, the horizontal can have two stages of compression—no second or booster compressor needed.

3. Easier maintenance. All parts of compressor accessible from working floor—no "high altitude" maintenance. Pressure is maintained only in the cylinder—so frame can be opened for maintenance without losing compression or the refrigerant.

4. More flexibility. Horizontals can be installed duplex—that is, two cylinders on different frames operated by the same driver.

Special reasons for using Worthington horizontal compressors include:

1. **wide range of sizes up to 1000 tons**
2. **double-seal housing (optional)**
3. **variable capacity control (optional) of various types, including automatic**
4. **famous Worthington Feather* valves—simplest, most efficient ever made.**

Investigate *more worth with Worthington.* Consult Classified Telephone Directory for nearest Worthington distributor. Worthington Pump and Machinery Corporation, Air Conditioning and Refrigeration Division, Harrison, N. J., specialists in air conditioning and refrigeration for more than 50 years.

*Reg. U. S. Pat. Off.

A-1139

WORTHINGTON

AIR CONDITIONING AND REFRIGERATION

THE MOST COMPLETE LINE . . . ALWAYS THE CORRECT RECOMMENDATION

Equipment Patents

Heat Exchangers

2,578,550 (The Air Preheater Corp.)—Multifluid heat exchanger.
2,578,917 (The Griscom-Russell Co.)—Tubeflo heat transfer section.
2,578,945 (Shell Development Co.)—Accumulator heat exchanger.

Tanks and Vessels

2,577,171 (John H. Wiggins and John W. Allen)—Multishell fluid storage tank, spherical type.
2,578,000 (Hammond Iron Works)—Diaphragm cover for liquid storage tanks.
2,578,658 (Chicago Bridge & Iron Co.)—Stabilizing means for lifter roof tanks.
2,579,065 (Paul Lambert, Paris, France)—Installation for underground storage receivers for liquids nonmiscible with water.
2,579,776 (John H. Wiggins)—Dry seal pressure type gas holder.
2,579,801 (John H. Wiggins)—Ventilated wall structure for dry seal gas holders.

Valves and Fittings

2,577,725 (Robert W. Drake)—Eccentric ball valve for high pressure lines.
2,578,590 (Perrault Bros.)—Safety valve.
2,578,628-9 (Joseph H. Hartman)—Valve protector.
2,578,630 (Joseph H. Hartman)—Valve shank protector.
2,578,782 (Saunders Valve Co. Ltd., Cwmbran, England)—Fluid control valve with flexible diaphragm closure member.
2,580,212 (Kotteryn Schmidt Anderson)—Plug valve actuator.

Furnaces and Accessories

2,579,001 (Shell Development Co.)—Liquid fuel burner with non-dribble tip valve.
2,579,215 (Shell Development Co.)—Wide range liquid fuel burner and method for increasing adjustability range of whirl-type atomizing burners.
2,579,350 (Phillips Petroleum Co.)—Petroleum heater type furnace.
2,579,829 (Shell Development Co.)—Liquid fuel burner with oil preheat.

Pumps and Compressors

2,578,285 (Milton Roy Co.)—Bellows pump for metering small volumes of liquids.
2,578,847 (Worthington Pump and Machinery Corp.)—Multistage centrifugal compressor.
2,578,798 (Economy Faucet Co.)—Positive displacement pump with disc-like impellers gyrating within a cylindrical enclosure.
2,578,966 (Cities Service Refining Corp.)—Pumping system for transferring volatile liquids such as propane and butane from bank cars to storage.
2,580,278 (Joseph B. Brennan)—Rotary positive displacement pump.

Tools

2,577,885 (Holly G. Greathouse)—Pipe wrench having sliding link and pivoted jaw piece.
2,578,316 (Beaver Pipe Tools, Inc.)—Power drive for a pipe tool.
2,578,317 (Beaver Pipe Tools, Inc.)—Switch lock for power driven pipe tools.
2,578,321 (Beaver Pipe Tools, Inc.)—Pipe rest.
2,579,278 (Ingersoll-Rand Co.)—Impact wrench.

Miscellaneous

2,578,700 (Fairbanks, Morse & Co.)—Rotary pump seal.
2,579,109 (Victor M. Langsett)—Fire extinguisher.

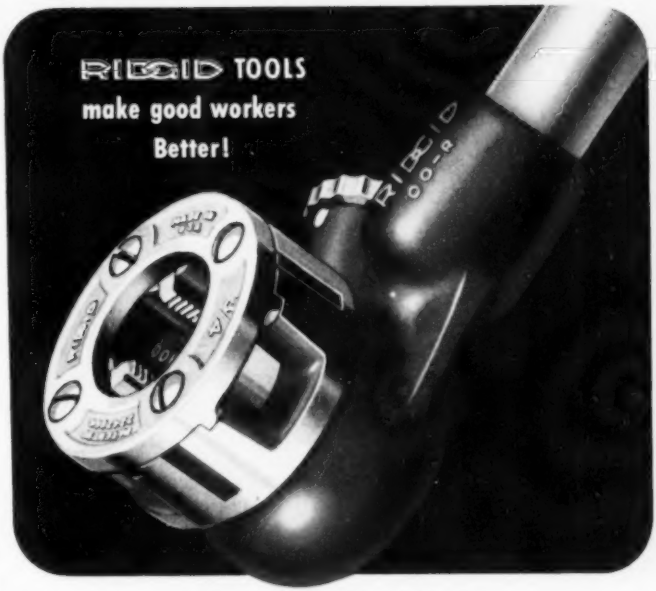
How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25 cents each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

WHY SKILLED WORKMEN Prefer

RIDGID

Small Ratchet Threaders



Drop head sets to thread ⅛" to 2"

These Drop Head Dies Give You *Extra* Fast Easy Pipe Threading

★ Heads snap into ratchet ring from either side, won't fall out.

★ Precision-cut alloy dies reverse for close-to-wall threads—no special dies needed.

★ 00R & 0R, ⅛" to 1"; 111R and 11R, ⅛" to 1¼"; 12R, ⅛" to 2". Conduit dies available.

★ Buy at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

★★★ RIDGID Work-Saver Pipe Tools ★★★

(To obtain more data on advertised products see page 248)

for greater efficiency . . .

INTALOX*

SADDLE PACKING

INTALOX — the brand new, "saddle-type", tower packing — can give you higher flow capacities, lower costs, and greater efficiency in any type of diffusional tower operation.

Made of tough, inert chemical porcelain or stoneware, INTALOX is especially designed to give a greater randomness to packing and to eliminate pattern packing, or "nesting". Thus, INTALOX provides more free space and its greater unit surface area is more fully accessible. Exhaustive tests show that INTALOX has a 30-35% lower pressure drop and a 15-20% higher flooding limit than Berl saddles — a 60-65% lower pressure drop and a 30%-40% higher flooding limit than Raschig Rings.

Low in weight and high in strength, INTALOX forms a truly interlocking bed with less side thrust and greater stability. Channeling is minimized; liquid distribution is more uniform; and flow capacities are greater.

By using Intalox in your packed tower, you can save on operational costs and reduce blower and pumping equipment requirements. Reduced tower sizes with consequent savings in construction are also a possibility.

Why not investigate Intalox, today? Just write for further information, technical data and samples. Ask about our new reference manual, "TOWER PACKINGS AND PACKED TOWER DESIGN", — 116 pages, 41 charts and figures — literally packed with information helpful to every engineer concerned with packed towers. Address: The U. S. Stoneware Co., Process Equipment Division, Akron 9, Ohio.

INTALOX
features:

- Greater Surface Area
- More Accessible Surfaces
- Greater Free Space
- Lower Pressure Drop
- Higher Flooding Limits
- Low Side Thrust
- Low Weight
- High Strength

U. S. STONEWARE

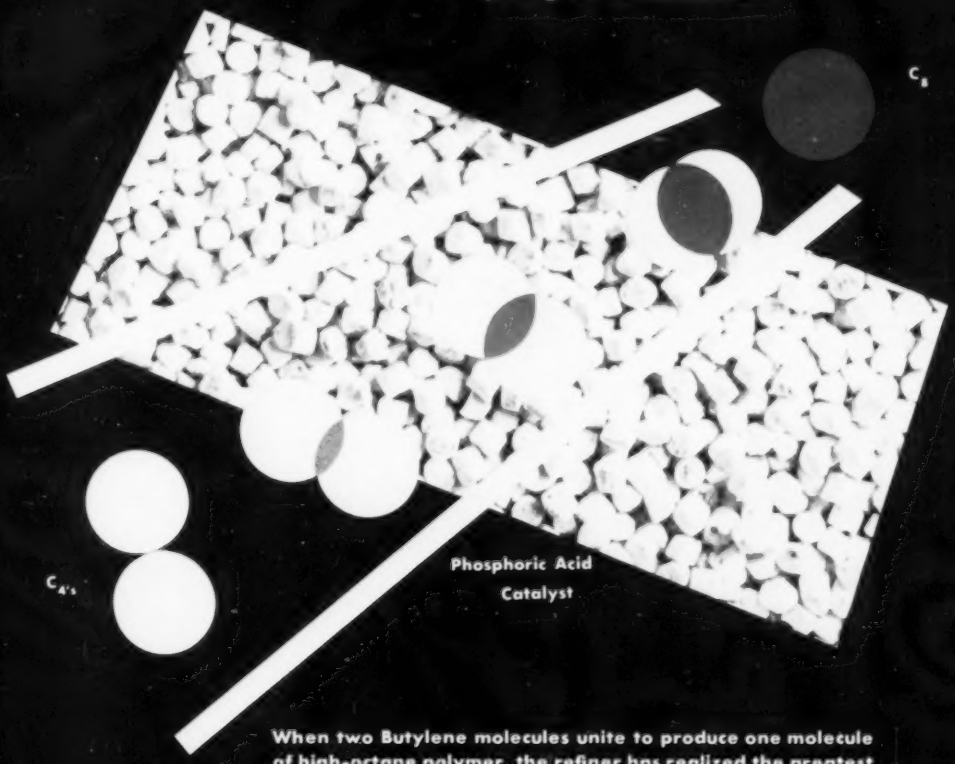
AKRON 9, OHIO

MANUFACTURERS AND FABRICATORS
OF CORROSION RESISTANT MATERIALS
SINCE 1865

*U.S. REG.

(To obtain more data on advertised products see page 2181)

catalytic polymerization



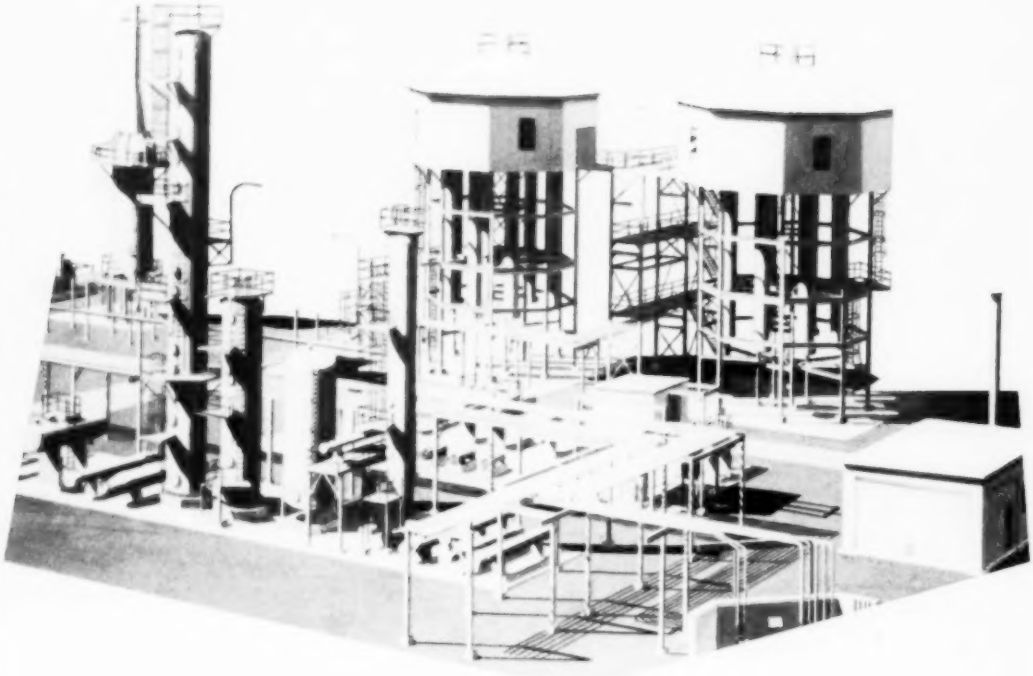
When two Butylene molecules unite to produce one molecule of high-octane polymer, the refiner has realized the greatest increase in product value in petroleum refining.

Foster Wheeler's extensive experience in designing and constructing many of the industry's largest catalytic polymerization, alkylation and isomerization units is available to refiners—anywhere in the world.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

4000 barrels of polymer per day



This catalytic polymerization unit, ...

probably one of the largest in the world . . . .

is now being built by Foster Wheeler.

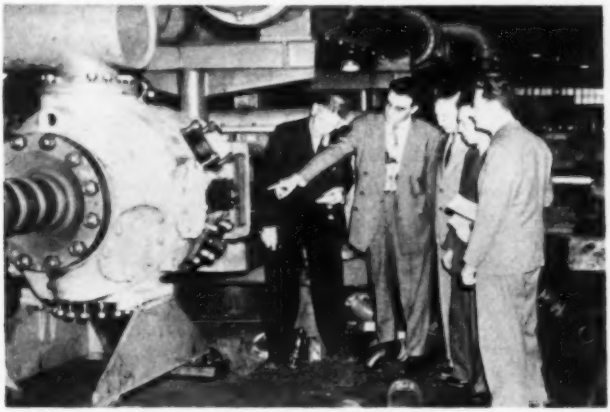
FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

NEWS OF SUPPLIERS

Manufacturers
Distributors
Engineering Firms

'Operation Impact' Brings European Oil Experts



James J. Julian of Worthington Pump and Machinery Corp. points out features of a balanced opposed type air compressor to Giorgio Millo of Italy, Edgard F. G. Demierbe of Belgium, Louis Schoorl and Eduard W. Insinger of Holland. These men are part of a group of ten petroleum experts from five free nations of Europe who were conducted through Worthington's Buffalo plant as a part of Economic Cooperation Administration's "Operation Impact", sponsored under its technical assistance program, to demonstrate modern American equipment and methods. The project was requested as an aid to the defense of the West by the Organization of European Economic Cooperation representing the Marshall Plan countries, whose mounting defense needs for oil products have been made more critical by the shut-down of the huge Iranian source of supply. This was only one of the stops made by the group in a six week tour of American plants.

Operations Manager Post Filled

Finley C. Nicholson has been appointed to the newly-created post of manager of operations for the Davison Chemical Corp., Baltimore, Md. A graduate of Purdue University in chemical engineering, Mr. Nicholson has been with Davison in various capacities since 1942, most recently as manager of the Cincinnati catalyst plant. He is succeeded in the latter position by J. W. Long, formerly superintendent of silica gel operations at Davison's Curtis Bay plant at Baltimore.

Moves Business To Tulsa

Norman K. Rector, Houston consulting engineer, is moving his business to Tulsa in mid-February. In Tulsa he also will be associated as a consultant with Waleo Engineering & Construction Co., as he has operated in Houston with Petroleum Engineering, Inc., which withdrew from the construction field about 15 months ago. The new address will be 2408 E. 4th Place, the same as that of Waleo.

Chemical Firm Elects President

John R. Hoover has been elected president of the B. F. Goodrich Chemical Co. with offices at the company's headquarters in Cleveland. He was formerly sales vice president of the company.

After graduation from Harvard University in 1925, Mr. Hoover joined the B. F. Goodrich organization as a chemist in their Akron laboratories. His sales career began in 1932, when he was made assistant sales manager of the company's rubber lined equipment department. In 1942 he assumed the direction of plastics materials sales and was made general sales manager of the B. F. Goodrich Chemical Co. when it was formed in 1944. A year later, Mr. Hoover was elected vice president of sales.

Rochester Firm Promotes Four

Frank S. Ward has been appointed general sales manager of the Taylor Instruments Companies, Rochester, N. Y. He has been industrial sales manager since 1945. His length of service dates back to 1917 when he started in the order department. In 1922, he moved to Boston as an industrial instruments salesman, and in 1931 was made manager of the Boston office. Mr. Ward returned to Rochester in 1936 and supervised sales of the companies' products in canning, textile and rubber industries until 1945, when he was named industrial sales manager.

Mr. Ward

Mr. Fleig

Mr. Ward is being succeeded by Albert J. Fleig, who, since 1945 has been divisional sales manager in charge of sales to the chemical, petroleum and canning industries. He has been with the company since 1919. In 1930, he took charge of all sales to the petroleum industry, later adding the chemical industry.

Other companies' changes include: George E. Heller to manager of a new industrial sales division handling products sold to the chemical industry, and Richard N. Pond to divisional sales manager handling the rapidly growing sales of industrial instrumentation to the petroleum and canning industries.

Dow Forms Two Subsidiaries

Dow Chemical Inter - American Ltd., and Dow Chemical International Ltd., are the respective names of two, new, wholly-owned subsidiaries formed by the Dow Chemical Co. The former will handle the parent company's business affairs in Mexico,

Cameron

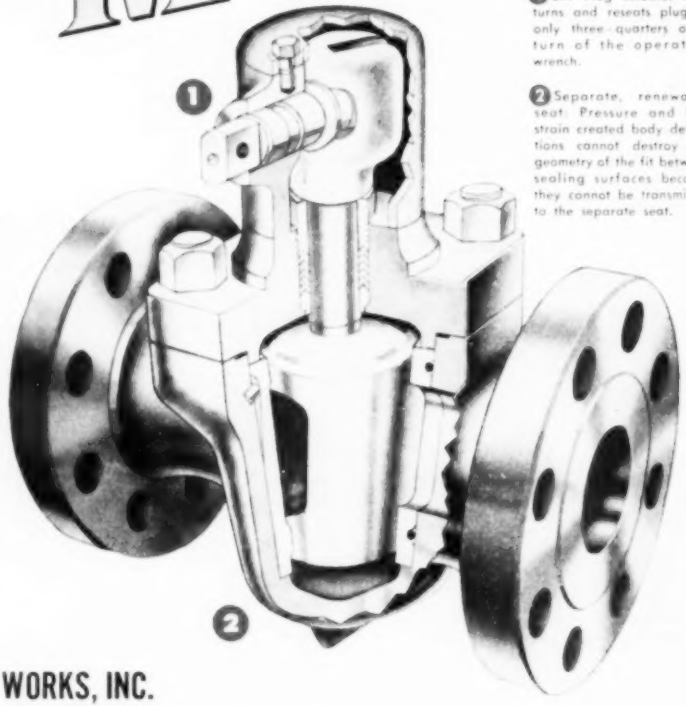
NON-LUBRICATED

LIFT-PLUG VALVES

set a new performance record in

MOLTEN METAL SERVICE

Molten lead, sodium and other high temperature services ranging up to 1600° F. are now being handled successfully with Cameron Non-Lubricated Lift Plug Valves. Utilizing the basic mechanical design of the Cameron Valve illustrated in cross-section at right, and employing special high temperature-resistant seals, these remarkable valves are performing with complete satisfaction in such difficult services where ordinary valves have required replacement every few weeks.



1 Lift-Plug actuator lifts, turns and reseats plug in only three-quarters of a turn of the operating wrench.

2 Separate, renewable seat. Pressure and line strain created body deflections cannot destroy the geometry of the fit between sealing surfaces because they cannot be transmitted to the separate seat.

Cameron **IRON WORKS, INC.**

P. O. BOX 1212, HOUSTON, TEXAS

Export: 74 Trinity Place, New York, N. Y.
Representative in the sterling area is: British Oilfield Equipment Co., Ltd., Duke's Court, St. James's, London S.W.1, England.

Central and South America and the West Indies, while the latter will perform similar functions in Europe, Asia, Africa and Australia.

Clayton S. Shoemaker, Dow's former eastern sales manager, heads the two newly established firms. Howard R. Ball, former export sales manager, has been named sales manager of the subsidiaries, and William R. Chilo, former accounting department supervisor, has been named treasurer and assistant secretary.

American Cy Chooses President

Mr. Kenneth C. Towe was elected president of American Cyanamid Co. at a meeting of the Board of Directors on January 22nd. He succeeds the late Raymond C. Gaugler, who died suddenly on January 11th. Mr. Towe has been a director of the company since 1939.

Mr. Towe

The new president joined the company in 1926 in the accounting department. He progressed through the positions of assistant treasurer and comptroller, and was appointed treasurer in 1939. Mr. Towe was promoted to vice president in charge of finance in 1945, a position which he occupied until his election as president. He is a graduate of Trinity College, now Duke University, located at Durham, N. C.

Mr. Howard Huston, vice president of the company, was elected a director to fill the vacancy created by the death of Mr. Gaugler.

Wins Horning Memorial Award

Daniel L. Pastell, combustion research group leader of the Du Pont Co., Wilmington, Del., was awarded the 1950 Horning Memorial Award last month at a meeting of the Society of Automotive Engineers in Detroit. The award is given annually to the author of the best paper on the adaptation of fuels to internal combustion engines. Mr. Pastell presented his paper, *Precombustion Reactions In A Motored Engine*, at the SAE summer meeting in June, 1950, at French Lick, Ind.

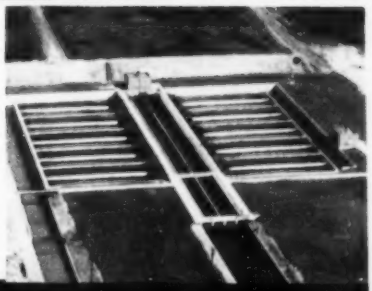
Mr. Pastell

Mr. Pastell is a graduate of the University of Washington. He joined Du Pont in 1947.

95% OF OIL RECOVERED FROM REFINERY WASTE WATER BY HARDINGE SEPARATORS

(Above: Part of the Hardinge installation of 11 rectangular clarifiers (oil separators) which remove about 300 barrels of heavy emulsion per day from 35,000 g.p.m. of refinery waste water at two Ohio refineries.

(Right: Aerial view shows primary clarifier in center with five secondary clarifiers on each side. The waste water enters through the culvert in the center and the effluent with 95% of oil removed flows out the canal at left.



300 Barrels Per Day Recovered

With increased demands for better methods of handling refinery waste water, systems using Hardinge Clarifiers as the primary separator have been gaining in popularity because of the high recovery of oil from the waste water. In this Ohio installation, the effluent from the Hardinge system contained 80 to 85% less oil than the previous system. Our engineers will provide you with the facts that you require.

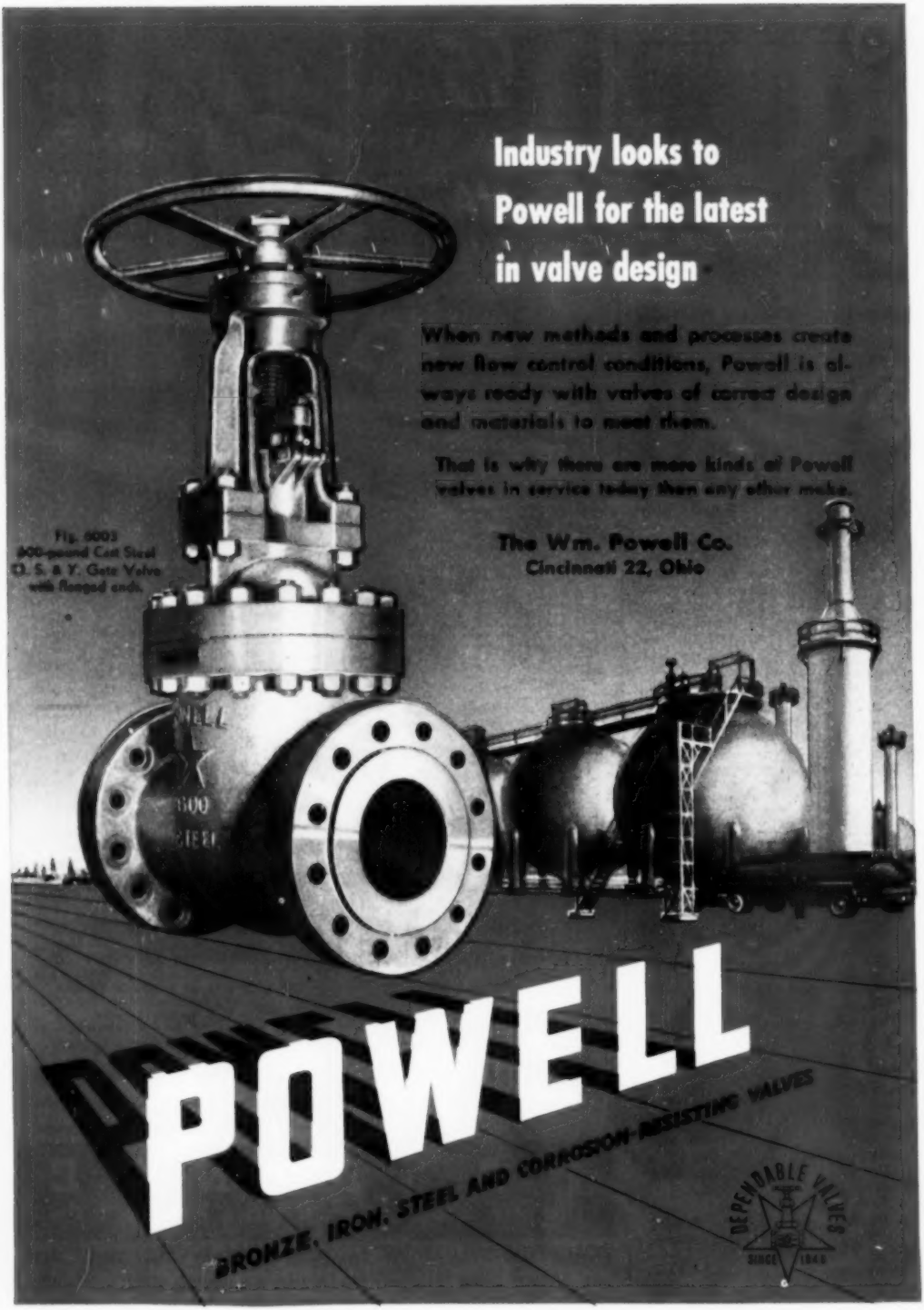
HARDINGE COMPANY, INCORPORATED

YORK, PENNSYLVANIA—240 Arch St. Main Office and Works

NEW YORK 17 • SAN FRANCISCO 11 • CHICAGO 6 • HIBBING, MINN. • TORONTO 1

122 E. 42nd St. 24 California St. 205 W. Wacker Dr. 2016 First Ave. 200 Bay St.

(To obtain more data on advertised products see page 248)


Industry looks to
Powell for the latest
in valve design
When new methods and processes create new flow control conditions, Powell is always ready with valves of correct design and materials to meet them.
That is why there are more kinds of Powell valves in service today than any other make.
The Wm. Powell Co.
Cincinnati 22, Ohio
Fig. 6003
600-pound Cast Steel
O. S. & Y. Gate Valve
with flanged ends.
POWELL
BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES
DEPENDABLE VALVES
SINCE 1843

News of Suppliers

Hauseman Joins Davison

David N. Hauseman has resigned as president of Houdry Process Corp. to become a marketing executive for the Davison Chemical Corp. He is a retired brigadier general of the U. S. Army. Born in Pottstown, Pa., General Hauseman received a B. S. degree in economics from the University of Pennsylvania in 1918, a B. S. in mechanical engineering from M.I.T. in 1928, and a master's degree in business administration from Harvard University in 1935. He went with Houdry in 1948, on the retirement of the firm's founder, Eugene J. Houdry.

Gen. Hauseman

AB&A Chooses Top Officers

C. W. Turner has been elected president of the American Bitumuls and Asphalt Co., and C. W. Stewart has been named to the newly-created position of vice chairman of the board of directors. Mr. Stewart has been president of the company, which is a subsidiary of the Standard Oil Co. of California. Mr. Turner was California Standard's Honolulu district manager since 1940. Before going to Honolulu, he was assistant manager of the company's lubricant division.

Mr. Stewart

Appointed Department Head

Dr. H. B. Coats has been appointed director of the newly-organized research and development department of the chemical plants division of Blaw-Knox Co. During the past year he has been active on atomic energy work.

Dr. Coats

Since receiving his doctorate in chemical engineering at the University in 1929, Dr. Coats has engaged in research and development work in the petroleum, pharmaceutical, and chemical fields. From 1929 to 1937, he was connected with the Leslie Laboratories at Ann Arbor, Mich. For the next six years

NEW! GEAR-DRIVEN PNEUMATIC OPERATOR FOR THROTTLING CONTROL SERVICE

Rotomotor

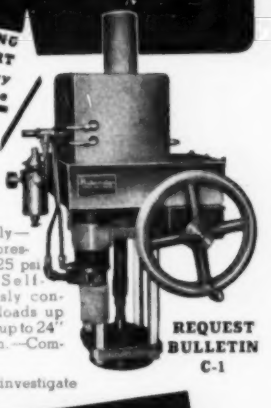
PNEUMATIC POWER POSITIONING OPERATOR

ACCURATE POSITIONING TO WITHIN 1/500th PART of STEM TRAVEL on Heavy Duty Throttling Service

A wholly new and different valve operator employing a reversible pneumatic motor and a precision gear driven screw stem, with these AMAZING advantages:

Operates on 100 psi supply—Sensitivity to instrument pressure changes as small as .025 psi—Perfect stability—Self-locking stem—Continuously connected handwheel—Stem loads up to 40,000 lbs.—Stem travels up to 24" Stem speeds up to 36" p.m.—Compact design.

So different, you will want to investigate its possibilities immediately.



REQUEST BULLETIN C-1

Cono-Controls

CONOFLOW CORPORATION
2100 Arch St., Phila. 3, Pa.

NOT 1 CENT for Repair Parts for 444 Nicholson Steam Traps Installed in 2 Years

Here is added evidence of the remarkably low maintenance costs of Nicholson expansion steam traps. In the 2 years Bradshaw & Co. have been distributing them in the Pittsburgh area they have installed 444 traps. But they have received not one order for repair parts. And examination of traps in drainage service for at least 18 months, at steam pressures to 250 lbs., showed no sign of valve cutting.

Pressure: 0 to 250 lbs. without change of valve or seat. Length: 9" to 40". 2 types: thermostatic, continuous flow.

Easily Installed, Low Cost

Because valve is easily adjusted to pass condensate at any temperature below 212° F., these traps are also widely used for regulating temperature of equipment.

FOR ALL EQUIPMENT Using Steam or Hot Water

Absorption Stills	Petrolatum Tanks
Agitators	Pipe Coils
Evaporators	Radiators
Gas Holders	Reboilers
Heat Exchangers	Steam Stills
Heavy Oil Tanks	Tar Tanks
Kettles	Wax Tanks

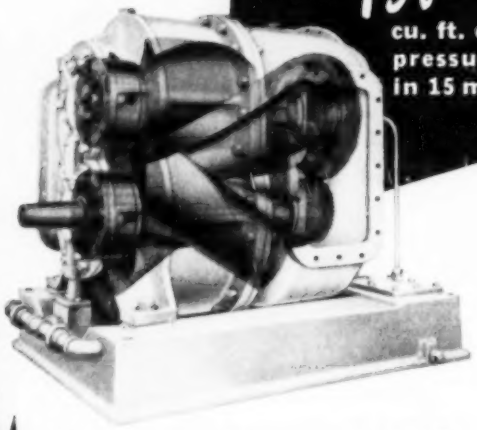
CATALOG 751 or see Sweet's

215 OREGON ST., WILKES-BARRE, PA.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

this STANDARDAIRE handled 1/3 billion cu. ft. of high pressure air in 15 months



Then we dismantled the unit

. . . FOUND IT AS GOOD AS NEW

- Unit 9B16-213, for 15 months of day and night outdoor service, was operated beyond its rated capacity to meet unforseen demands. It was replaced by a larger Standardaire Blower. The engineer of this plant asked that the hard working unit be sealed and returned to our factory so that he personally could observe the disassembly and measurements for wear.
- Main and Gate Rotors like new interior of blower completely dry and free of oil—no wear in other internal parts.
- Timing Gears on Gate and Main Rotors wear very slight—no increase in back lash could be detected.
- Axial clearance of Main Rotor Shaft Thrust-Radial Bearing, increased less than .0005"—other bearings in perfect order.
- Even at the extremely high peripheral speed of these gears, they were found to be very quiet in service.
- Standardaire Blowers are sturdy—precision built units with proved staying power.

Write for specific data—Dept. F38. Read Standard Corporation, 370 Lexington Ave., New York 17, N. Y.

AXIAL FLOW STANDARDAIRE BLOWER

BLOWER-STOKER DIVISION

READ STANDARD CORPORATION

NEW YORK • CHICAGO • ERIE • YORK • LOS ANGELES

News of Suppliers

he was with the Upjohn Co. of Kalamazoo. He joined the research staff of Blaw-Knox in 1943.

Personnel Changes

Du Pont Co.—Four members of the petroleum chemicals division, Wilmington, Del., have been advanced to new posts: T. Baldwin Prickett to planning manager; Richard O. Bender to assistant technical manager; Arthur F. Bowe to laboratory coordinator; and Robert F. Harwick to sales promotion manager.

American Cyanamid Co. — G. L. Glespen, on leave for one year, appointed as chief of the chemical and packaging branch of the Petroleum Administration for Defense's materials division. He is replaced as technical supervisor of the petroleum chemicals department by R. B. Wainwright, formerly production coordinator for the Company's catalyst plants.

Westinghouse Electric Corp. — George E. Goodrich to assistant manager, industrial department, apparatus division. Prior to the promotion he was resale manager of the company's Middle Atlantic district with headquarters in Philadelphia.

Expansion, Transition

Celanese Corp. of America, chemical division, has opened new offices in Chicago. Thomas G. Davis, district manager, and G. J. Boyer, midwest district representative head the office. Formerly located at the Merchandise Mart in Chicago, the new offices are at 101 East Ontario St.

National Aluminate Corp., has opened sales offices in New York City at 141 East 44th St. The new offices are being established to make it easier and faster for many Eastern users of the company's products to contact the company's sales representatives for consultation regarding catalyst requirements. Mr. Gage Averill has moved his headquarters from Chicago to New York to head the new offices.

Black, Sivalls & Bryson, Inc., has opened a California sales office in San Francisco. Mr. Ross Baze, west coast sales manager, Los Angeles, will also head the San Francisco office. He will be assisted by Mr. Warren J. May, sales engineer. The address is 55 New Montgomery St.

American District Steam Co. Inc. have opened a branch office located at 401 Architects Bldg., 415 Brainard St., Detroit 1, Mich. Mr. Harry P. Osgood is the district manager of the new branch.

The Petroleum Industry

STOPS RUST!

with

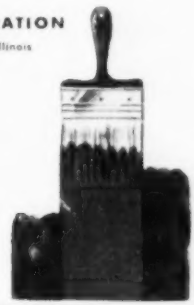
RUST-OLEUM

The Practical Way to Save Pipes, Tanks, Derricks, Buildings, Pumps, Roofs, Fences

Ask the maintenance men who battle rust daily! They'll tell you that RUST-OLEUM is the practical answer. (1) It may be applied directly over surfaces *already rusted* without removing all the rust. Wirebrushing and scraping with sharp scrapers to remove rust scale and loose particles is all that is usually required . . . eliminating costly sandblasting and chemical pre-cleaning . . . often enabling one man to do the work of two. (2) RUST-OLEUM *beautifies as it protects in all colors, aluminum, and white.* (3) RUST-OLEUM *stops rust* on every rustable metal surface indoors and out.

See how RUST-OLEUM can cut your maintenance costs. Prompt delivery from Industrial Distributor stocks in principal cities in the United States and Canada.

RUST-OLEUM CORPORATION
2476 Oakton Street • Evanston, Illinois



May be applied directly over rusted surfaces without removing all the rust!
Available in All Colors, Aluminum and White

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- ☐ Full Details on Free Survey
- ☐ Complete Literature
- ☐ Nearest RUST-OLEUM Source

it isn't a plug –
it isn't a gate –
it isn't a globe –

It's an

ORBIT VALVE

(Forged Steel)

The Orbit Forged Steel Valve is a smoother operating, more compact and easier handled tool built for today's production and processing operations. All principal parts are constructed of Steel Drop Forgings. These forgings, due to the hot working of the steel, form a dense homogeneous structure that better resists wear. No flaws, cracks or porous metal will be found—consequently, Steel drop forgings represent the ultimate in material for pressure equipment such as Orbit Forged Steel Valves.

The operation of the Orbit Valve is entirely different from that of conventional Valves. It provides globe valve seating, in that the Core Face moves directly into the Body Seat to effect a positive shut-off: Plug Valve turning, because the Orbit Core rotates a quarter turn in the Valve Body; and Gate Valve wedging, as tapered wedges are formed on the Orbit Stem, which wedge the Core into or away from the Valve Seat. Orbit Forged Steel Valves are *full round* opening.

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NACE Agenda Includes Sessions On Refinery Corrosion Topics

MAINTENANCE painting, organic corrosion inhibitors, steel graphitization under high temperature conditions, and cooling water corrosion problems are among subjects included in a technical session devoted to the refinery industry as part of the 1952 annual meeting of the National Association of Corrosion Engineers in Galveston, Texas, March 10-14.

The complete program calls for the delivery of 32 technical papers in nine symposia, two round-table discussions and the first-run showing of a technical motion picture, in color, on corrosion fundamentals. Some revision in the schedule can be expected.

The first day of the convention, Monday March 10, starts with registration at 9 A.M. and continues all day. Committee meetings and setting up of exhibits will be carried on all day also.

Galveston's Buccaneer Hotel will be headquarters for the conference. Exhibits and meetings will be held on the Galveston Pleasure Pier, across the street. R. L. Bullock will act as technical program chairman.

Among the symposia scheduled, there are separate papers to be presented on the chemical and refinery industries, also the oil and gas, electrical and communication, and protective coatings industries.

Refinery Industry

R. R. Pierce, Pennsylvania Salt Mfg. Co., Philadelphia, will present a paper entitled *Economics of Industrial Maintenance Painting;* George E. Purdy, Tretolite Co., St. Louis, will deliver *Corrosion Prevention of Distillation Process Equipment With Organic Inhibitors.*

Graphitization of Carbon and Low Alloy Steel Plate Used For High Temperature Service by J. G. Althouse, Lukens Steel Co., Coatesville, Pa. is on the agenda, along with *Treatment of Recirculated Cooling Water,* by J. K. Rice, Cyrus Wm. Rice & Co. Inc., Pittsburgh, Pa.

Chemical Industry

Corrosion by Sulfur and Sulfur Compounds at Elevated Temperatures, by W. Z. Friend and E. N. Skinner, International Nickel Co., New York City; *Kel-F Application in Corrosive Systems,* by L. C. Rubin and W. O. Teeters, M. W. Kellogg Co., Jersey City; *Corrosion by Fluorine and Fluorine Compounds,* by Ralph Landau, Scientific Design Co. Inc., New York City, are among those of special interest to those in chemical and allied industries. Others include: *Effects of Mercury and Aluminum and Non-Ferrous Alloys,* by R. H. Brown, Aluminum Co. Of America, New Kensington, Pa., and *Polarographic Studies of Corrosion of Iron and Ferrous Alloys by Sulfur Dioxide,* by A. H. Gropp, University of Florida at Gainesville.

Oil & Gas Symposia

Stress Corrosion Cracking of Steels Under Sulfide Conditions, by C. N. Bowers, W. J. Maguire and A. E. Weile, Gulf Oil Corp., Houston; *Cracking of High Strength Steels in Hydrogen Sulfide Solutions,* by J. P. Fraser and R. S. Treseder, Shell Development Co., Emeryville, Calif.; and *The Role of Oxygen in Corrosion and Cathodic Protection,* by R. B. Comeaux, Humble Oil & Refining Co., Baytown, Tex. are also in store for convention goers.

Other Papers

Three other papers worthy of interest to those in the petroleum processing field are: *A Laboratory Method for Evaluating Steam Condensate Return Line Corrosion Inhibitors,* by Harold I. Patzelt, National Aluminate Corp., Chicago; *Values of Surface Preparation and/or Pre-Treatment For Use In Conjunction With Various Outstanding Paint Systems in Industrial and Marine Atmosphere,* by J. C. Hudson and F. Fancutt, British Iron and Steel Research Assn., London, England; and *Metallizing Economics In Modern Industry Surface Application Studies,* by R. J. McWaters, Metallizing Engrg. Co. Inc., Long Island, N. Y.

The program gives a partial list of over 80 exhibitors. Exhibits are to be of the same style as in previous years. Value of equipment to be shown is placed at several million dollars. The annual banquet and presentation of the Whitney and Speller Awards is scheduled for Thursday, March 13, at 7 P.M.

Catalytic Reforming To Be Discussed at WPRA Conclave

A tentative technical program for the Western Petroleum Refiners Assn.'s 40th annual meeting has been announced. The meeting is to be held at the Plaza Hotel in San Antonio, March 31-April 2. According to J. C. Day, managing secretary, final arrangements for the general session will soon be made.

The first technical meeting is scheduled for the afternoon of March 31st, and will feature a paper on gasoline volatility by R. C. Alden, Phillips Petroleum Co., Bartlesville. Following will be the prepared discussions and a series of reports by various WPRA technical committees. C. W. Berger, Berry Asphalt Co., Waterloo, Ark., will preside.

Featuring the April 2nd morning session is a report by H. M. Smith of the Bureau of Mines at Bartlesville, entitled *WPRA-U.SZM Bureau of Mines Joint Research Project On Storage Stability and Compatability of Distillate Fuels.* Also on tap for this gathering is *The Atlantic Reforming Process,* presented by the Atlantic Refining Co., Philadelphia.

A staff member, not yet selected, of the Houdry Process Corp., Philadelphia, will present a paper on "Houdriforming." A talk on refinery cost accounting by E. M. Skinner, Socony-Vacuum Oil Co., Augusta, Kans., will conclude the technical sessions. C. C. Tate, Phillips Petroleum Co., Bartlesville, will preside.

Oil Man's Calendar

FEBRUARY

American Petroleum Institute, Lubrication Committee of Division of Marketing, first yearly meeting, Hotel Book-Cadillac, Detroit, Mich., Feb. 18-19.

American Institute of Mining & Metallurgical Engineers, Hotel Statler, New York, Feb. 20-21.

Natural Gasoline Association of America, Permian Basin regional meeting, Lincoln Hotel, Odessa, Texas, Feb. 29.

MARCH

American Society for Testing Materials, Pittsburgh district meeting, joint meeting with **American Institute of Mining and Metallurgical Engineers,** Mellon Institute, Pittsburgh, Pa., March 3.

Mfgrs. Standardization Society of Valve & Fittings Industry, annual meeting, Hotel Commodore, New York City, March 3-5.

American Society for Testing Materials, spring meeting and committee work, Hotel Statler, Cleveland, Ohio, March 3-7.

National Electrical Manufacturers' Association, Edgewater Beach Hotel, Chicago, Ill., March 10-13.

National Association of Corrosion Engineers, 8th annual conference and exhibition, Municipal Pier, Galvez and Buccaneer Hotels, Galveston, Texas, March 11-14.

American Society for Testing Materials, Chicago district joint meeting with Milwaukee section, American Society of Mechanical Engineers, Engrs. Society of Milwaukee Bldg., Milwaukee, Wisc., March 12.

American Institute of Chemical Engineers, regional meeting, Biltmore Hotel, Atlanta, Ga., March 16-19.

American Society of Tool Engineers, 20th annual meeting, Chicago, Ill., March 17-21.

Western Petroleum Refiners Association, annual meeting, The Plaza Hotel, San Antonio, Texas, March 31-Apr. 2.

American Chemical Society, 121st national meeting, Hotels Statler, Buffalo and Lafayette, Buffalo, N. Y., March 24-27. (Also to be held in Milwaukee, Mar. 31-April 3.)

APRIL

National Packaging Exposition, Auditorium, Atlantic City, N. J., April 1-4.

American Society of Lubrication Engineers, annual meeting, Hotel Statler, Cleveland, Ohio, April 7-9.

National Petroleum Association, semi-annual meeting, Hotel Cleveland, Cleveland, Ohio, April 16-18.

Independent Petroleum Assn. of America, mid-year meeting, Deshler-Wallick Hotel, Columbus, Ohio, April 28-29.

Natural Gasoline Association of America, 31st annual convention, Rice Hotel, Houston, Texas, April 30-May 2.

How to Effect Temperature Change

in Heat Exchangers

Most Efficiently

This simple diagram shows the difference between the flow of liquid over Wolverine Trufin* as compared to the flow over plain tube.

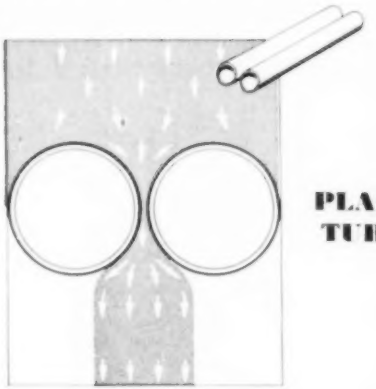
Because Trufin has a greater outside surface area per foot, thereby effecting greater working capacity, this distinctive integral finned tube is capable of increasing the efficiency of your heat exchangers, oil coolers or condensers.

Reference to the accompanying diagram will show you how Trufin presents much more contact area to the fluid and also allows more free area for its flow.

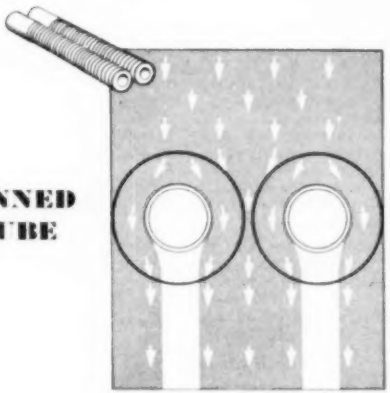
These advantages contribute immeasurably to: (1) an increased heat transfer capacity of the unit, and (2) a decrease in pressure drop. These, in turn, often permit the use of smaller equipment, thus reducing wear and tear.

*Reg. U. S. Pat. Off.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through Unifin Tube Co., London, Ont.



PLAIN TUBE



FINNED TUBE

This illustration shows the results found in our laboratory tests. A plain tube, ¾" O.D. and Trufin having ⅝" root diameter were used in the tests (the outside diameter of the fins is comparable to that of the ¾" plain tube). The center distance between the plain tube and the finned tube conformed to the code requirements of a minimum 15/16" spacing. Both oil and water were used in the tests.

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Energy Sources Subject of New Book Coauthored by Ayres of Gulf Research

Energy Sources—the Wealth of the World, by Eugene Ayres and Charles A. Scarlott; 6¾ x 9¼ in.; VII + 344 pages; stiff cloth binding; indexed and illustrated; $5.00. McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y.

Nearly four years ago Eugene Ayres of Gulf Research and Development Corp. undertook the tremendous task of assembling and collating data on the world's energy resources—past, present and future. His findings were presented at the annual meeting of the American Petroleum Institute in Chicago in Nov., 1948, in the paper "Major Sources of Energy." The paper was received with considerable interest, and 6,000 reprints of it have since been distributed.

The logical outcome of that interest made its appearance last month—the book *Energy Sources—the Wealth of the World*, coauthored by Ayres and Charles A. Scarlott of Westinghouse Electric Corp. The book brings together pertinent statistics and information on the world's energy sources—where they come from, how large our reserves are, how fast they're being used up, and what we can expect in the future.

Although the book in general follows the same pattern as the original paper, it includes much material of necessity omitted in the earlier work. Treating the subject in book form has allowed the inclusion of more critical analyses of resources, descriptions of many of the energy-conversion processes, enumeration of the chief sources of waste of energy, detailed explanations for the conclusions reached, and the substitution of the latest statistical and interpretative data.

Ayres and Scarlott waste no time in driving home, and quite forcefully, the utter futility and fallacy of thinking that our present-day sources of energy—coal, petroleum, natural gas, and other fossil fuels—are without end. In an effort to translate the life of the earth (an estimated 2 billion years) into an understandable yardstick they liken it to the lifespan of a young man just turned 21 years. The period during which the earth's deposits of fossil fuels were formed corresponds to "5 years" of our man's life—and they will be completely dissipated in only "5 minutes."

From the petroleum technologist's viewpoint, "Energy Sources" may prove discouraging. Engineers accustomed to believing that the oil industry is relatively young will be amazed to learn that the Chinese were deliberately drilling wells to produce natural gas for space heating, lighting and manufacturing purposes before 1,000 B.C., and that an oil well was reportedly completed on the island of Zante in the Ionian Sea in 400 B.C. This oil was distilled by stretching a hide over a cauldron of boiling oil and wringing out the condensed liquid, which was used as a fuel for lamps.

Of the two authors, Eugene Ayres is well-known in the petroleum industry. He is technical assistant to the executive vice president of Gulf Research and Development, and has been a frequent contributor to PETROLEUM PROCESSING and other publications. His latest article appeared in the January issue of this magazine ("Synthetic Liquid Fuels—When and How?" p. 41). Charles A. Scarlott is editor of the *Westinghouse Engineer*.

Any person who is fundamentally interested in supplying energy in one form or another will find *Energy Sources—the Wealth of the World* not only informative and interesting, but also provocative. How much longer can we depend on abundant supplies of our conventional fuels—and then what?

—W.F.B.

Technical Data on Piping Design Gathered Into One Volume

Piping Design and Engineering, First Edition; 8½ x 11 in.; IX + 221 pages; stiff cloth binding; $10.00. Grinnell Co. Inc., Providence, R. I.

With the aid of their experimental engineering staff, Grinnell Co. Inc. published this book with engineering data and technical information suitable to the design and application of pressure piping systems. A considerable amount of the information compiled in this book was formerly available only from a number of other sources.

Expansion and stresses are presented quite thoroughly. Velocity and temperature drop are considered with empirical equations and charts. Piping materials are selected by using the charts supplied, which include materials of construction, ASTM designation, and their general applications.

General principles for design of pipe supports are covered regarding hanger and support locations, selection and design of the appropriate hanger or support, locating of guides, anchors, sway bracings or vibration dampeners, and the calculation of hanger and support loads.

Specifications for the fabrication and welding of all carbon steel piping materials are suggested for systems operating from —20° F. to 775° F. There are 38 pages of supplemental tables covering such variables as properties of saturated steam, heat losses, temperature and pressure conversions, and properties of pipe.

Besides acknowledging assistance from their own staff, Grinnell expresses their indebtedness to Mr. S. W. Spielvogel, assistant division engineer, mechanical engineering department, of the Consolidated Edison Co. of New York. To him fell the task of preparing the section on expansion and stresses.

E.F.G.

Use Of Signs and Indicators Sustains Engine Performance

Practical Preventive Maintenance for Gas-Diesel and Diesel Engines, by James H. Caldwell; 6 x 9 in.; 68 pages; $2.00. The Kokosing Press, Mt. Vernon, Ohio.

That nothing should be disassembled in a two or four cycle engine until the operator has a better knowledge of what is taking place inside of the engine is a point constantly emphasized in this book. Personal initiative and sound thinking are necessary for any maintenance program, and the methods discussed place them in a logical and systematic working plan.

In discussing maintenance programs two basic facts are brought out: 1) certain vital parts last longer and operate better if not frequently taken apart, and 2) operation until complete destruction is not only foolish but costly.

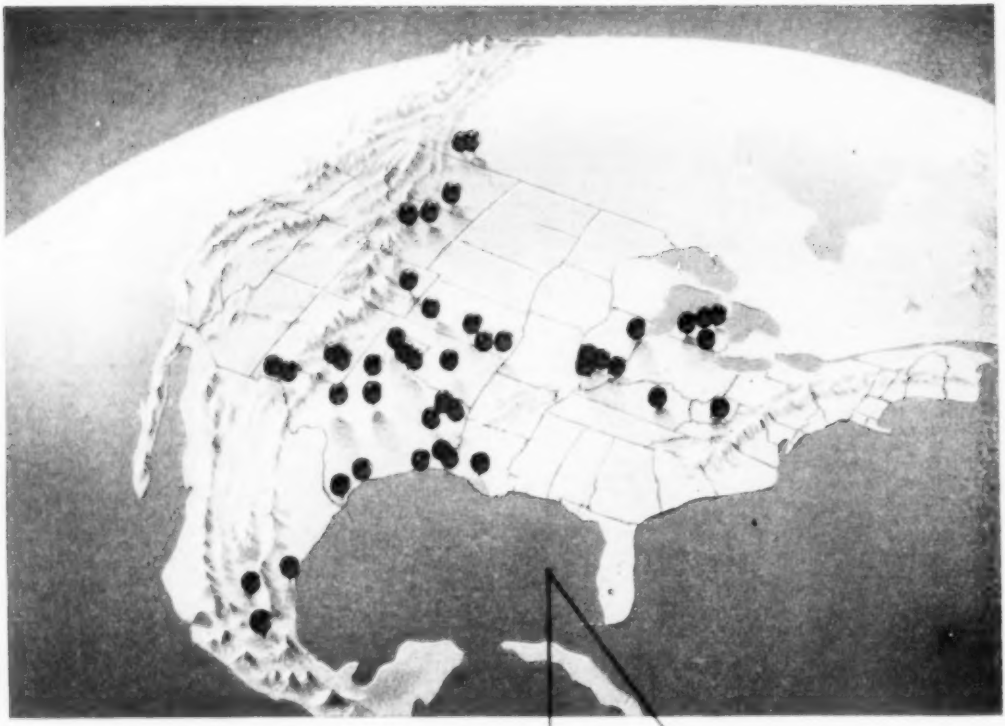
Signs and indicators are suggested for measuring and determining vital engine performance factors, such as presence of blow-by, and compression and oil ring condition by lubricating oil consumption records. Any malfunctioning of these factors would be reflected immediately by an increase in lubricating oil consumption.

The majority of the indicators or tests suggested for determining the engine's condition can be taken while the engine is running. This means that the engine is available for service at all times. The instruments recommended for recording the tests are very simple.

A chart included in the book, illustrates what daily, weekly, monthly, and semi-annual readings do to keep the operator "ahead" of the engine. Use of the graphs and charts indicates well in advance when engine tampering or overhaul is necessary. The purpose of the entire program is to realize maximum life on all parts. Premature failures will be a thing of the past if followed conscientiously.

James H. Caldwell, the author, is the service engineer for the Cooper-Bessemer Corp. The original idea of the preventive maintenance program described in the book was suggested by D. L. Gallogly, manager of the service department of Cooper-Bessemer.

E.F.G.



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Phillips 66

PERCO DIVISION—Bartlesville, Oklahoma

* A SERVICE MARK

(To obtain more data on advertised products see page 218)

REFINING TRENDS

Current Data on Crude Runs, Product Supply and Demand

Surplus of Heating and Fuel Oil Stocks in Interior Districts

THE economic position of U. S. refiners in February continues sound under normal conditions. In view of the continued high rate of product demand, however, two possible factors in coming weeks could materially affect the balance of supply and demand of heating oils and heavy fuel oils. Below normal temperatures for any long period in the east and New England could create a shortage in this area for some suppliers, with consumption in general running 10 to 15% higher than a year ago.

Also, with refineries now running at over 90% of operable capacity, labor troubles which resulted in shutting down any number of plants through strikes could materially affect the current rate of product output. This factor is weighted by the belief in some quarters that the CIO oil workers union, through the dates of its contracts with the oil companies, has maneuvered itself into a position where it could close down a considerable portion of refinery capacity early in the year should wage negotiations fall through.

The pinch in heating oils in the east, if it should materialize, would be one of dislocation of supplies, rather than any overall lack of sufficient volume in storage. Stocks of heating oils (kerosine and distillates) in primary storage on Jan. 26 (API data) on the East Coast remained about 15% higher than on Jan. 27, 1951. The uncertain factor, and contributing greatly to the development of any shortage, is the totally unknown volume of storage in this area in distributors' tanks, the so-called secondary storage.

Heating oil stocks in the Gulf Coast refining districts on Jan. 26 this year were 26% higher than on Jan. 27, 1951. In the middle west refinery stocks were over 50% larger than at the same point in 1951 and for the country east of California they were 26% larger. The large decrease in stocks this year in California made the total volume of heating oil stocks for the entire U. S. only 16% greater Jan. 26th than on Jan. 27, 1951.

The situation as regards residual fuel oil stocks on the East Coast continues to give concern to shipping interests and some industry there. The difficulty for refiners in general lies more in the distribution of these stocks than in any general lack of supply.

In the East Coast district stocks of residual fuel oils on Jan. 26 were only 4.3% higher than on Jan. 27, 1951; in the Gulf Coast area they were 7.5% larger. In the Ind.-Ill.-Ky. district and in the Inland Texas-N. La.-Ark. district stocks of residual fuel oil were 73% and 87% higher, respectively, than in late January of 1951.

For the country east of California, heavy fuel oil stocks on Jan. 26 were 27% larger than on Jan. 27, 1951. In California stocks of residual fuel oils as well as of distillate oils have been greatly reduced over the past year. As a consequence, stocks of residual fuels for the entire country on Jan. 26 were 4.1% lower than on Jan. 27, 1951. Details as to stocks of heavy fuel oils by districts for the two dates is given in Table 1.

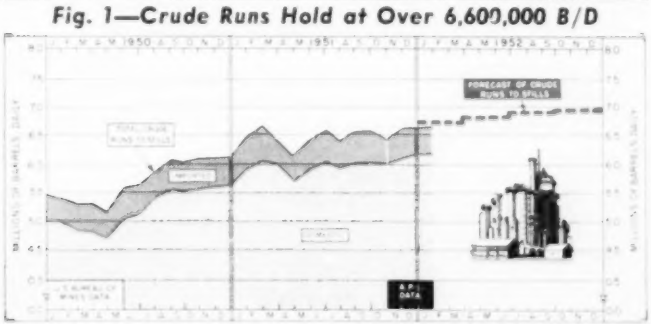
Gasoline stocks in refinery storage begin to be watched with more interest starting about this time of year. On Jan. 26, stocks of 133,861,000 bbls. for the entire U. S. were 7,600,000 bbls. higher than on Jan. 27, 1951. East of California stocks of 118,662,000 bbls. were 8,800,000 bbls. larger. However, the current figures represent a buildup from the low point of early last November of nearly 24,000,000 bbls. for the entire U. S. and east of California by around 23,000,000 bbls.

Table 1—Residual Fuel Oil Stocks—January 1952-51 by Refining Districts

(A. P. I. Data)

DISTRICT	Jan. 26, 1952	Jan. 27, 1951	% Change to 1952
East Coast	9,424	9,031	+ 4.3
Gulf Coast	8,013	7,449	+ 7.5
Appalachian	704	497	+ 41.6
Indiana-Illinois-Kentucky	5,528	3,192	+ 73.1
Oklahoma-Kansas	1,541	1,121	+ 37.5
Inl. Texas-N. La.-Ark.	1,274	650	+ 87.4
Rocky Mountain	1,055	825	+ 28.2
U. S. Except California	27,481	22,763	+ 27.2
California	11,244	17,615	- 36.2
Total U. S.	38,725	40,378	- 4.1

Fig. 1—Crude Runs Held at Over 6,600,000 B/D



Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Jan. '52 API*	6,269	344	6,613
Jan. '52 BM	6,264	346	6,610
Change	+ 5	- 2	+ 3
% Change	+ 0.1	- 0.7	+ 0.1

* Through Jan. 26.

Total (1000 bbls.)

(Bureau of Mines Data)

	Domestic	Foreign	TOTAL
12 Mos. '51*	2,188,196	181,779	2,369,975
12 Mos. '50	1,918,854	178,013	2,096,867
Change	+ 269,342	+ 3,766	+ 273,108
% Change	+ 14.0	+ 2.1	+ 13.1

* Includes Emg. API data.

BM Forecast of Crude Runs to Stills, 1952

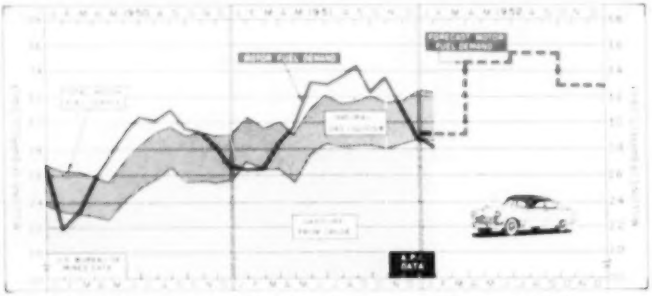
For Week Jan. 26, 1952—3rd qtr. by quarters:
1st Q., 6,650; 2nd Q., 6,710; 3rd Q., 6,800; 4th Q., 6,850

Yields on Crude Runs to Stills

	Gasoline	Kerosine	Dist. Fuels	Resid. Fuels
	%	%	%	%
Jan. '52 API*	42.9	8.2	21.6	20.1
Jan. '51 API	41.9	9.7	22.1	19.5
Nov. '51 BM	42.6	8.7	20.4	19.8
Jan. '51 BM	41.6	8.9	21.7	20.6

* Through January 26.

Fig. 2—Motor Fuel Supply Remains at High Level



* Natural Gas Liquids include gasoline blended at refineries, and used direct as motor fuel

Fig. 3—Gasoline Stocks Approaching 1951 Peak

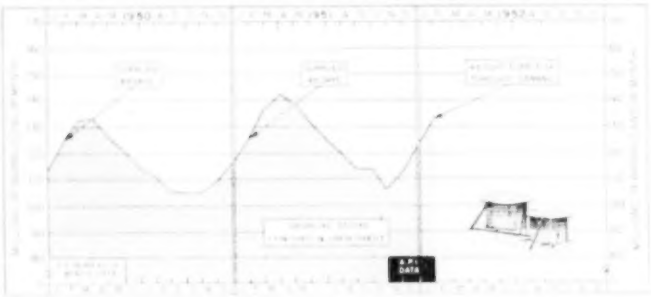


Fig. 4—Heating Oil Demand Sharply Up in January

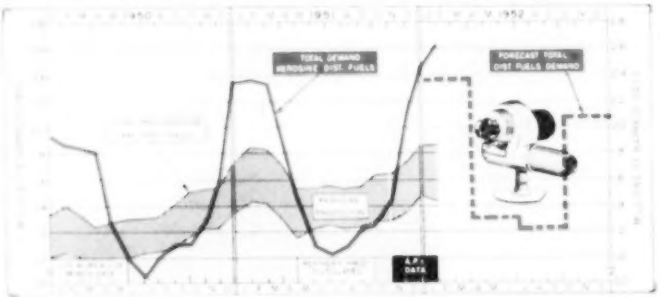
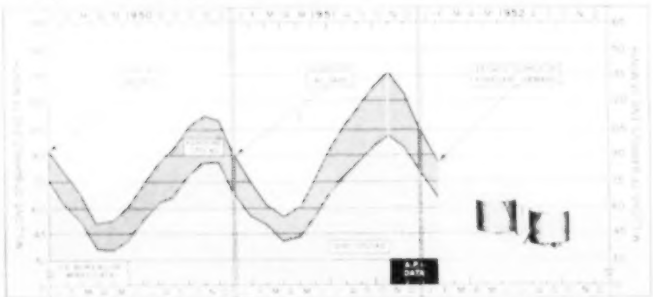


Fig. 5—Heating Oil Stocks Cut Over 20,000,000 Bbls.



Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Jan. '52 API*			
Jan. '52 BM			
Change			
% Change			

* Through Jan. 25

Total (1000 bbls.)
(Revised to Motor Data)

12 Mos. '51*			
12 Mos. '50			
Change			
% Change			

* December from API data

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Jan. '52 API*	
Jan. '52 BM	
Change	
% Change	

* Through Jan. 25

Total (1000 bbls.)
(Revised to Motor Data)

12 Mos. '51*	
12 Mos. '50	
Change	
% Change	

* December from API data

BM Forecast of Motor Fuel Demand, 1952

	1st Q	2nd Q	3rd Q	4th Q	Year
1952					

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Jan. '52 API*	
Dec. '51 API	
Nov. '51 BM	
Jan. '52 BM	

* Through January 25

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Jan. '52 API*			
Jan. '52 BM			
Change			
% Change			

* Through Jan. 25

Total (1000 bbls.)
(Revised to Motor Data)

12 Mos. '51*			
12 Mos. '50			
Change			
% Change			

* December from API data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Jan. '52 API*			
Jan. '52 BM			
Change			
% Change			

* Through Jan. 25

Total (1000 bbls.)
(Revised to Motor Data)

12 Mos. '51*			
12 Mos. '50			
Change			
% Change			

* December from API data

BM Forecast of Heating Oils Demand, 1952

	1st Q	2nd Q	3rd Q	4th Q	Year
1952					

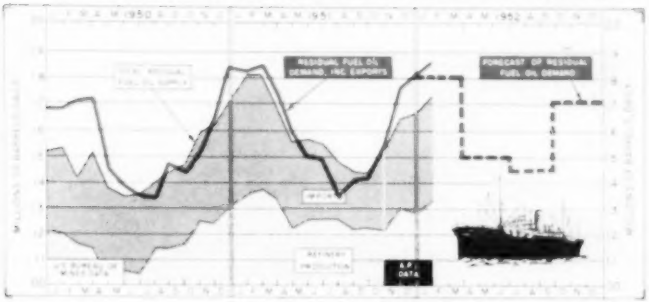
Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
Jan. '52 API*			
Dec. '51 API			
Nov. '51 BM			
Jan. '52 BM			

* As of Jan. 25

Fig. 6—New High for Residual Demand in January



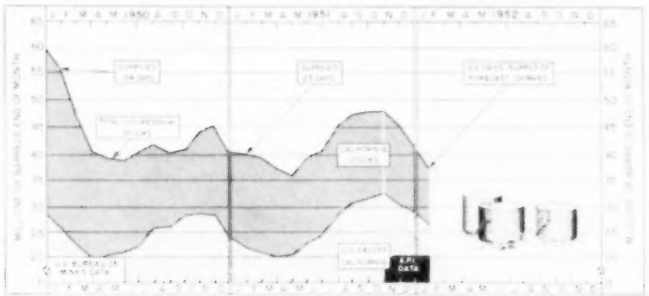
Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Jan. '52 API*	1,900	400	2,340
Jan. '51 BM	1,808	347	2,155
Change	+92	+53	+185
% Change	5.1	15.3	8.6
* Through Jan. 26			
Total (1000 bbls.)			
12 Mos. '51	458,542	134,470	593,012
12 Mos. '50	442,247	108,196	550,443
Change	+16,295	+26,274	+42,569
% Change	+3.7	+24.3	+7.8

* December from API data.

Fig. 7—Residual Stocks Below 40,000,000 Bbls.



Residual Fuels Demand

Daily Average (1000 bbls.)

Jan. '52 API*	1,900
Jan. '51 BM	1,840
Change	+60
% Change	3.3
* Through Jan. 26	
Total Demand (1000 bbls.)	
12 Mos. '51*	672,381
12 Mos. '50	580,111
Change	+92,270
% Change	15.9

* December from API data.

BM Forecast Residual Fuels Demand, 1952

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Q
1,900	2,000	2,000	1,900	1,800	1,700	1,600	1,600	1,700	1,800	1,900	2,000	1,825

Residual Fuel Stocks

1000 bbls. end of month

	U. S. Except California	Total U. S.
Jan. '52 API*	27,491	38,725
Jan. '51 API	29,020	42,449
Nov. '51 BM	28,000	41,374
Jan. '51 BM	32,928	46,317

* thru Jan. 26

Fig. 8—Production and Demand of Natural Gas Liquids

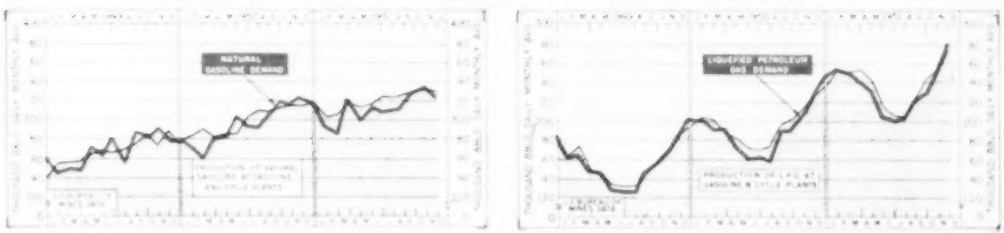
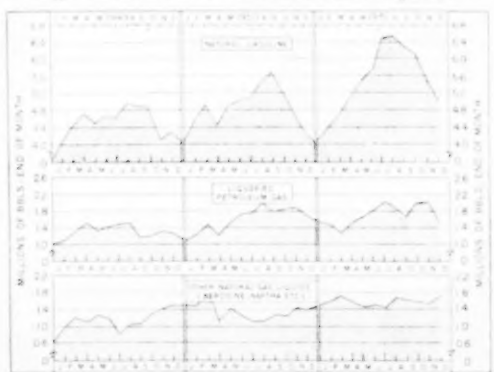


Fig. 9—Stocks of Natural Gas Liquids



Natural Gas Liquids Statistics

	Production (1000 bbl. day avg.) Natural Gasoline	LPG	TOTAL	Demand* (1000 bbl. day avg.) Natural Gasoline	LPG	TOTAL
Jan. '52	1,900	1,100	3,000	1,900	1,100	3,000
Jan. '51	1,800	1,000	2,800	1,800	1,000	2,800
Change	+100	+100	+200	+100	+100	+200
% Change	5.6	10.0	7.1	5.6	10.0	7.1
* Through Jan. 26						
Total Production (1000 bbl.)				Total Demand (1000 bbl.)		
12 Mos. '51	700,000	400,000	1,100,000	700,000	400,000	1,100,000
12 Mos. '50	650,000	350,000	1,000,000	650,000	350,000	1,000,000
Change	+50,000	+50,000	+100,000	+50,000	+50,000	+100,000
% Change	7.7	14.3	10.0	7.7	14.3	10.0

Stocks, End of Month (1000 bbl.)

	By Type of Product: Natural Gasoline	LPG	Other Products*	By Location: Refineries	Gasoline Plants	TOTAL
Nov. '51	1,500	900	1,200	2,500	1,100	3,600
Jan. '51	1,400	800	1,100	2,300	1,000	3,300
Nov. '50	1,450	850	1,150	2,400	1,050	3,450

* Including refinery stocks of finished and unfinished gasoline, naphthas, special naphthas, kerosine, distillate fuel oil, residual fuel oil, and crude oil.

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FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

●

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

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WHAT'S NEW!

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Materials
Processes
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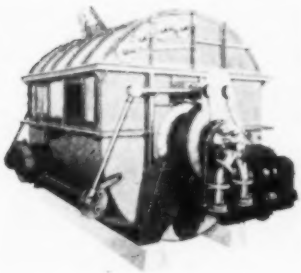
Reviewed by **WILLIAM C. UHL**, *Equipment Editor*



Vacuum Filter and Hood Quickly Disposes of Toxic Products

The Oliver Continuous Vacuum Filter, with vapor tight hood, handles exceedingly toxic products. It is also of use for handling inflammable products in an inert or special atmosphere to prevent oxidation or other chemical changes. It is engineered to keep the space surrounding the filter slightly on the vacuum side to prevent the escape of gases or fumes. Units are available in standard or chemically resistant construction, with a wide range of filter areas. Oliver United Filters Inc., New York, N. Y.

Circle No. **1** *on Reply Card*

Redesigned Bath Adds Efficiency To Cloud and Pour Point Tests

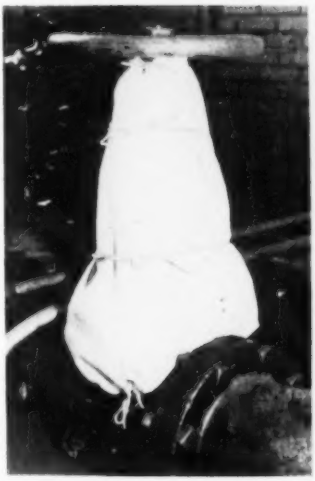
The "Frigistat" bath has been completely redesigned to provide frost-free, efficient operation, with a minimum of temperature control adjustments expressly for A.S.T.M. Method D 97, i. e., *Standard Method of Test for Cloud and Pour Points*. Although manually operated, the bath can easily be maintained within ± 2° F. There is a 7-unit test chamber and a dry ice chamber, which when full, plus an efficient ¼ H.P. pump, will reduce temperature of the test chamber to −90° F. in about one-half hour. The cooling medium is circulated in the test chamber through copper coils, which do not allow interchange of fluid between chambers. Made of steel, except for a heavy Bakelite top, the housing is finished in silver-tone Hamerloid baked enamel. Inner chambers are pure spun copper; all pipes and fittings are of brass. Overall dimensions: 24½ in. wide by 13 in. deep by 18 in. high. Immediately available. Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle No. **2** *on Reply Card*

Vane Type Rotary Pumps Have Capacity Range: 25-1000 gpm

A new heavy duty, vane type rotary pump has been announced with a range of nominal capacities from 25 to 1000 gpm. and speeds from 850 to 210 rpm. Six models are available in eight sizes, including pipe openings from 2 to 12 suction inches and 2 to 10 discharge inches. All models are positive displacement, sliding vane design in which the pressure of the liquid being pumped maintains contact of the vanes against the liner. The pumps are to be manufactured in both internal and external bearing design; the external bearing models being especially suited for non-lubricating liquids such as gasoline and kerosine. Pumps have a built-in relief valve and can be manufactured in either standard fitted, bronze fitted, or in all bronze construction. Worthington Pump & Machinery Corp., Harrison, N. J.

Circle No. **3** *on Reply Card*



Valve Covers, Made of Dynel, Feature Safety and Economy

Designed to fit all styles and sizes of valves and flanges, "ChemKovers" provide protection to workers against leakage, and are said to have sufficient strength to contain sprays resulting from gasket or packing failures in pressurized lines. The covers are made of acid and caustic resistant Dynel, and are said to cost only one-third as much as previous covers. Covers can be removed easily and quickly when lines require repair. Mine Safety Appliances Co., Braddock, Thomas, and Meade Sts., Pittsburgh 8, Pa.

Circle No. **4** *on Reply Card*

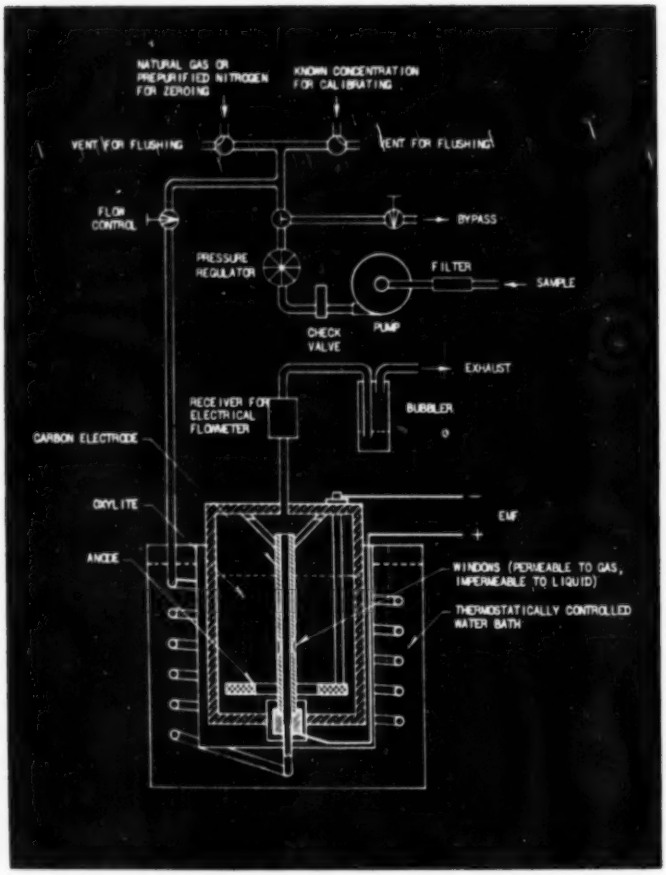
Safety Scoreboard Designed for Promoting Accident Prevention

Designed to act as a constant reminder of days worked without a lost-time injury, the new "Ipco" Safety Scoreboard is said to convey the thought that responsibility rests with each employe. Measuring 20 in. wide by 30 in. high, it is large enough to be seen at a distance. Colors used are green background with white letters, with two blackboard finish panels enclosing the word DAYS so that it can be kept up to date by marking in the record with chalk. Industrial Products Co., 3108 N. Fourth St., Philadelphia 33, Penna.

Circle No. **5** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.



NEW OXYGEN INDICATOR, schematic flow diagram

Easy Maintenance in O_2 Indicator

The new MSA Type C-2 Oxygen Indicator has been designed for improved operation and maintenance. Maintenance has been simplified over its predecessor, the Type C, because it has only three points which need attention: the carbon electrode must be replaced periodically; the detector cell requires an ounce or two of "Oxylite" about every two weeks; and a No. 2 flashlight dry cell must be replaced every week.

Operation is illustrated in the schematic flow diagram. Heart of the indicator is the detector cell, essentially a primary cell with a metallic and a hollow carbon electrode immersed in the electrolyte, "Oxylite," and housed in a plastic container. The sample is passed through the hollow carbon electrode. Hydrogen evolved causes "polarization" of the cell, manifesting itself in a decrease of the generated voltage and current. Oxygen from the sample diffuses through the wall of the carbon electrode and combines with the hydrogen, thus producing a "depolarization." Consequently, the amount of oxygen in the sample affects directly the electric current being generated by the cell. To eliminate temperature effects on the current delivered by the cell, it has been placed in a thermostatically-controlled water jacket which is maintained at a constant temperature of approximately 30° C.

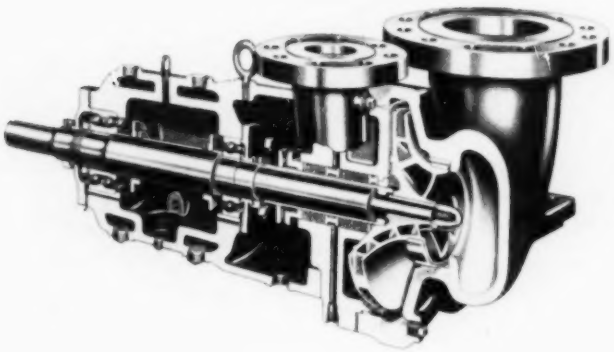
The entire instrument is contained in a metal case, 13½ x 17½ x 10 in., suitable for surface or flush-mounting. It is designed for permanent installation and continuous operation. Power supply required is normally 110 v., 60 cycle, single phase A.C. The detector cell requires a sample flow of about 75 cc./min. To reduce transfer lag from point of test to the analyzer, a by-pass is provided as an integral part, permitting a surplus of sample to flow to the instrument. When available gas sample pressure exceeds 12 in. water, flow can be maintained without an external motor-driven pump. An electromechanical switch automatically turns the alarm and control circuits off when sample flow is manually interrupted or when the indicator case is opened. Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh 8, Penna.

Circle No. 6 on Reply Card

Fluid Flow Checked Visually by Use of Sight-Flow Indicator

Designed for checking liquid flow in piping systems by visual examination of the fluid in the line, the "Trin-Vue" Sight-Flow Indicator features a tight, positive seal, made tighter as greater pressure or vacuum is applied. Two windows, located on opposite sides of the indicator, allow maximum visibility. The windows are sealed by use of O-Ring gaskets and "Truarc" retaining rings. There are no bolts to be adjusted, thus pressure on the glass is equally distributed at all times. A perfect seal at 3 psi. continues without failure at higher pressures up to 2000 psi. The unit is easily demountable and tamperproof. Its design permits use of stock size tubing, as well as the use of steel flanges, rather than flanges of special materials. Pressure ratings range from 350 to 50 psi. with Pyrex, to four times that with Herculite. The unit is available in a range of materials in addition to steel, in sizes from ½ in. to 4 in. Trinity Equipment Corp., 472 Westfield Ave., East Roselle Park, N. J.

Circle No. 7 on Reply Card



HYDROCARBONS AND CHEMICALS handled by this pump

Process Pump Works at High Temperatures and Pressures

A new centrifugal pump, the "Peerless Type PR", for petroleum hydrocarbons, water, and chemical solutions at high temperatures and pressures, provides capacities up to 1000 gpm, operating heads up to 625 ft, and case pressures up to 600 psi. Temperatures of liquids pumped can be up to 850° F. It is a heavy duty, horizontal, vertically-split, center-line mount centrifugal, driven by an enclosed horizontal electric motor of standard manufacture. Both pump and driver are mounted on a substantial fabricated steel base. The manufacturer states that Type PR pump has excellent NPSH characteristics. A top suction—top discharge model and an end suction—top discharge model are available. The same bearing housing size accommodates several pump sizes, providing interchangeability of spare parts. The liquid ends of the pump can be of any required alloy. For ease of inspection and maintenance, the cantilever type bearing housing and spacer type coupling permit complete removal of the rotating parts without disturbing the piping or the driver. Peerless Pump Div., 301 West Ave. 26, Los Angeles 31, Calif.

Circle No. 8 on Reply Card

Pourable Cement Permanently Sets Anchor Bolts in Half Hour

Anchor bolts, for permanently fastening machinery or equipment of any type to concrete, can now be set quickly by using "Por-Rok" Quick Setting Cement. The manufacturer states that within 15 to 30 minutes after application of the compound, the bolt is securely anchored. It can be applied cold, thus eliminating any heating hazard. Por-Rok can also be used to repair concrete floors. It is self-bonding, self-levelling, oil resistant, and will not shrink. A compression strength of 4500 lbs. psi. is verified. The Hallemite Manufacturing Co., Dept. PPR, 2446 W. 25th St., Cleveland 13, Ohio.

Circle No. 9 on Reply Card

DID YOU MISS THESE?

The following items, reviewed originally in the December, 1951, "What's New!" have aroused considerable interest. They are repeated briefly as a service to those who might have missed them. For details or literature, use the regular Reply Card in this issue.

Liquid Level by Sound Waves

Bogue Sonic Liquid Level Indicators, Bulletin 82, four pages describing a new instrument for measuring liquid level in, for example, oil storage tanks, to within 0.1 in., utilizing the principle of reflecting supersonic waves emanating from the tank bottom up to the liquid surface and return. Bogue Electric Mfg. Co., Paterson 3, N. J.

Circle No. 10 on Reply Card

Distillation Packing, Columns

Distillation Packing and Columns, Bulletin 12, 16 pages of technical data, including tables and charts on a new patented, protruded form of laboratory distillation packing, designed particularly for high efficiency columns and close separations, and described recently in an American Chemical Society paper by M. R. Cannon of Penn State College. Scientific Development Co., Box 795, State College, Penna.

Circle No. 11 on Reply Card

Insulated Electrical Heating Helps Prevent Pipe Freeze-Ups

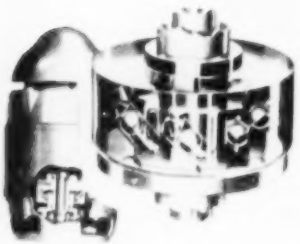
"Thermwire," a new flexible, electrical heating cable, will heat outdoor piping to prevent freezing or keep viscous fluids moving in cold weather. It consists of a heavy-gage, nickel-chromium resistor wire with an abrasion-resistant insulating sheath. It can be used in the conventional wrap around technique or imbedded in asphalt or concrete, for example, to eliminate ice from drives and walks in the winter. Thermwire is made up in two packaged sets: 80 ft., 400 watts, 115 v.; and 160 ft., 800 watts, 230 v.; each with 10-ft. lead and plug. Thermostatic control is optional. Edwin L. Wiegand Co., 7605 Thomas Blvd., Pittsburgh 8, Penna.

Circle No. 12 on Reply Card

Tiny Capacity Laboratory Pump Made with Teflon Construction

"Allchem" positive displacement pumps, in 1 to 20 gpm. sizes for small volume laboratory or process work, have Teflon impellers and packed stuffing boxes and a choice of Teflon or Graphitar self-lubricating bearings. They have stainless steel casings and shafts and will operate at up to 40 psi with high lift. Pump design includes self-priming. Pumps available in port sizes $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{3}{8}$ in. pipe tap, with pulley drive base assembly or base-mounted, direct connected electric motor. Eco Engrg. Co., 12 New York Ave., Newark 1, N. J.

Circle No. 13 on Reply Card



Automatic Ball-Type Back Stop Prevents Pump Motor Reversal

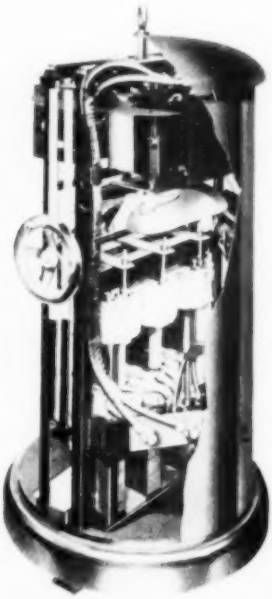
When electric motor current stops, a vertical turbine water pump will back-spin unless some means are provided to prevent motor reversal and avoid damage to pump bearings. A new method for preventing reversal of their vertical hollowshaft motors has been developed by U. S. Electrical Motors, Inc., using balls as shown in the illustration. When the motor starts, centrifugal force throws the hardened steel balls out of engagement with the stationary member. When the motor stops, gravity pulls the balls down, and one of them engages between the rotating member and stationary ratchet, thus preventing reversal. The backstop is designed with a different number of balls and ratchet flutes which multiplies the possible number of locking positions in one rotation, thereby reducing impact and resultant wear to a minimum. U. S. Electrical Motors Inc., 200 East Slauson Ave., Los Angeles 54, Calif.

Circle No. **14** *on Reply Card*

Rectifier Stack Failure Stopped In New D.C. Welding Machine

Extensive field testing has shown that a new heavy duty, direct current welding machine, designed for all industrial uses where DC welding is required, is free of stack failure, according to the manufacturer. This is accomplished by directing a high velocity downdraft of cool air over the rectifier stacks before passing this air through other parts of the machine. The blast is expelled at the base of the unit. The welder retains all construction features of the maker's companion AC model, including a case-diameter fan and "wind tunnel" design to assure adequate, efficient air flow over all energized parts. The machine is available in 200, 300, and 400 amp. ratings. A. O. Smith Corp., Milwaukee, Wisc.

Circle No. **15** *on Reply Card*



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by Glidden
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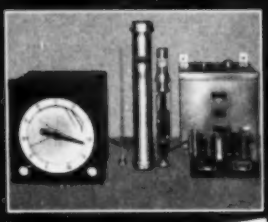

GAGETRON Applied to Measurement of Catalyst Level

New industrial application of atomic energy employs radium and hydrogen tube. Catalyst level is measured by number of atomic impulses passing through the counter tube. The primary element is the GAGETRON.

The GAGETRON is manufactured under Graham Patent No. 2,565,963.

FREE! Safety Code for use of radium. Also GAGETRON Bulletin No. 149.

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122 N. Madison Tulsa 6, Okla.

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SEPARATORS
Now used by largest products pipeline operators to remove free water and solids from stream.

EXCEL-SO
COMBINATION SEPARATOR AND DEHYDRATORS
are now used by many major companies to dehydrate LPG at bottling plants and bulk terminals.

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SEPARATORS AND MICRONIC FILTERS
for 5 micron efficiency built in capacities 10 to 3000 G. P. M.

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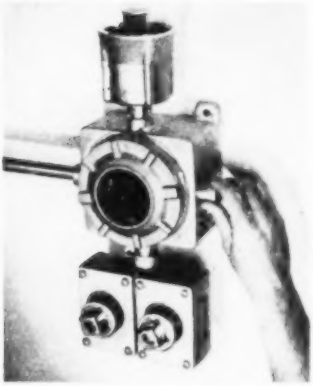
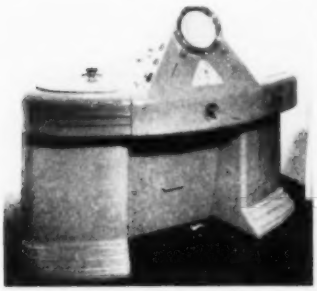


Alarm Unit Accounts for All Vapors in Dangerous Atmosphere

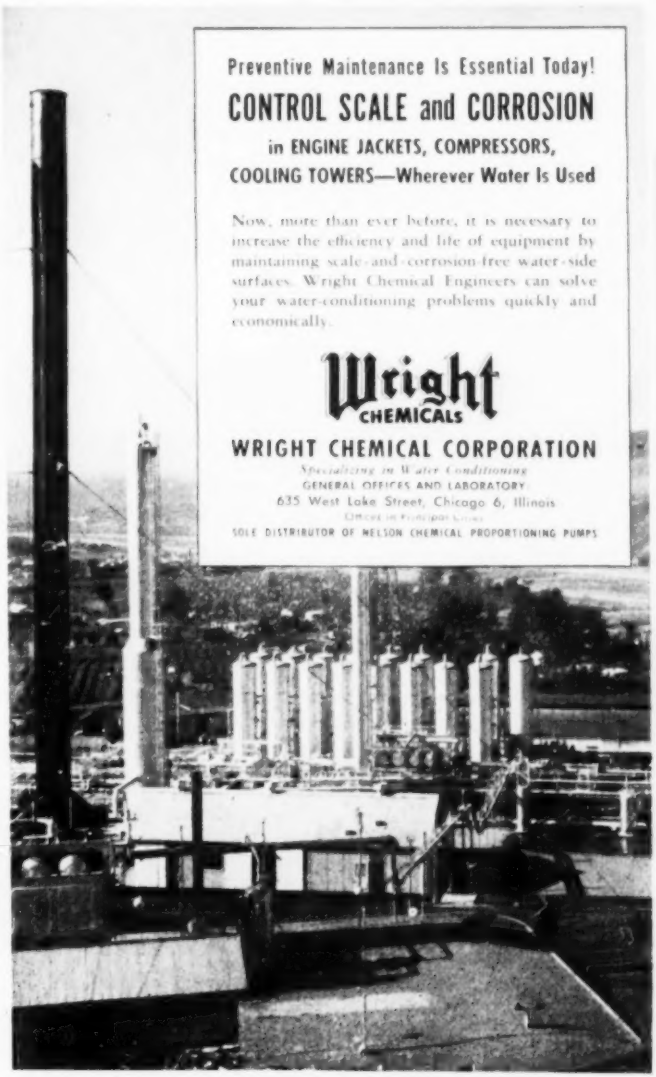
A completely explosion-proof combustible gas alarm unit, Model EE, can be directly installed in areas where gas or volatile liquids are used, stored, or handled, to serve as a continuous guard against the build-up of any kind of explosive vapors. Presence of any vapor is signalled by a bright red indicator light as well as by remote alarm units. Either self-reset or lock-in arrangements can be provided to give a choice between an on-off indication of gas, or one which must be manually reset. Completely A.C. operated, the alarm is designed for rough-service locations. It contains no meters or meter-type sensitive relays, but utilizes an electronic trigger-tube circuit to convert the sensing-unit signals into alarm indications. The single knob control combines a turn-to-balance and a press-to-test function. Stand-by power consumption from the 115 volt line is 15 watts. Johnson-Williams Ltd., 2686 Third St., Palo Alto, Calif.

Circle No. **16** *on Reply Card*



Screen Magnification on Electron Microscope Gets Clear Image

In the Philips Electron Microscope (EM-100), screen magnification of the microscope is continuous from 1000X to 60,000X and is capable of producing micrograms of 30 Angstroms resolution or better. Accelerating potentials of 40, 60, 80 and 100 kv are available. The microscope has a beam oscillator for rapid determination of exact focus, eliminating the necessity for a series of exposures with conjunctive time loss. A through focal series is readily obtained by means of an additional fine focus control. The unit has an extremely large field and permits recording in a single photograph, areas which might otherwise require a mosaic of six individual sections. The unit requires three-phase, 4-wire A. C. 220/380 V. 60 cycle supply, with a neutral wire and ground lead. Line variations of 5% are permissible. The power consumption is 2½ to 3 Kva. Cooling water of approximately 60° F. and flowing at a rate of two quarts per minute with a pressure of 15 to 20 psi is required. Provision must be made for handling the discharge water. An easy-to-use spindle-type specimen holder operating with a small volume air lock, permits resumption of work in less than 30 seconds after reloading. The vacuum system is so ar-


Preventive Maintenance Is Essential Today!
CONTROL SCALE and CORROSION
in ENGINE JACKETS, COMPRESSORS,
COOLING TOWERS—Wherever Water Is Used
Now, more than ever before, it is necessary to increase the efficiency and life of equipment by maintaining scale-and-corrosion-free water-side surfaces. Wright Chemical Engineers can solve your water-conditioning problems quickly and economically.
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Offices in Principal Cities
SOLE DISTRIBUTOR OF NELSON CHEMICAL PROPORTIONING PUMPS

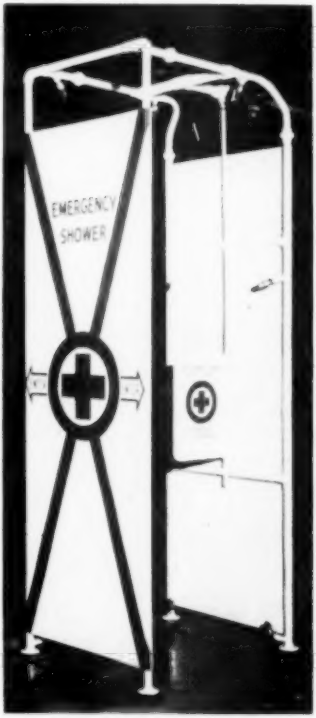
(To obtain more data on advertised products see page 248*)*

ranged that the mechanical pump need only be run for a short time every three or four hours of operation. North American Philips Co., Research & Control Instruments Div., 750 So. Fulton Ave., Mt. Vernon, N. Y.

Circle No. **17** *on Reply Card*

High Speed Emergency Shower Has Multiple Spray Nozzles

Multiple sprays, properly located, provide the new Model SE 5010 Logan emergency shower with a maximum of fast action for removing and diluting dangerous chemicals, acids, and the like from the body of a chemical workman. For example, in addition to the conventional overhead sprays, the unit has four bottom sprays directed upwardly to reach under smocks, coats, etc. Water directed in this manner assures thorough wetting between the legs, under the buttocks and calves. The feet are reached by four streams directed from holes at the base of the shower. In addition, two special sprays play on the eyes and face without interfering with sight or breathing. The shower can



be entered from two sides and is instantly activated by the slightest pressure on a gate which swings in either direction. The valve remains open after being activated until it is manually closed, thus leaving the user's hands free. Other models are available with fewer sprays and in less elaborate construction. Logan Emergency Showers, Inc., P. O. Box 111, Glendale, Calif.

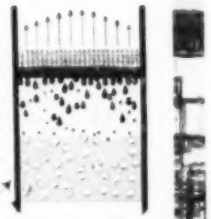
Circle No. **18** *on Reply Card*

YOU GET

Increased Throughput from Existing Equipment

WITH METEX MIST ELIMINATORS

Many refiners have found by experience that Metex Mist Eliminators, installed in stills, towers, drums, evaporators and similar equipment, have increased throughput of on-grade production and reduced operating costs by *removing 95% plus of liquid entrainment.* These knitted wire units literally "wipe out" the liquid droplets entrained in gases. Gases pass through and on . . . freed of entrainment. Liquids fall back against the rising flow.



EASILY INSTALLED NO MOVING PARTS

Full details on these entrainment separators — sizes, shapes, construction and engineering data — are found in our new 8-page bulletin. Write for your copy today. Just ask for "Metex Mist Eliminators."

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METAL TEXTILE CORPORATION

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Trade Literature

First Aid for Scrap Salvage

Rapid Identification of Some Metals and Alloys, 50 page booklet covering spot tests for most common metals and alloys met in scrap drives, as an aid in identification. International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Circle No. **19** *on Reply Card*

Kellogg Laboratories

The Kellogram, 1951 Series, No. 2, is devoted to an extensive, illustrated description of the petroleum and chemical research facilities of the M. W. Kellogg Co., 225 Broadway, New York 7, N. Y.

Circle No. **20** *on Reply Card*

Hi-Temp Tubing Failures

Some Experiences In Service, by John J. B. Rutherford, Bulletin TR-516, 40-page illustrated booklet presents the results of many investigations of failures of carbon steel, intermediate chromium-molybdenum alloy steel and stainless steel tubing in boilers, cracking stills, heaters and heat exchangers during service at elevated temperatures and pressures in the power, oil and chemical processing fields. Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

Circle No. **21** *on Reply Card*

Automatic Temperature Control

Hauck Fuel Oil Heaters, Catalog No. 714; six pages describing design and construction advantages of automatic-temperature controlled steam type fuel oil heaters for heating heavy grades of fuel oil; heater capacities and dimensions included; illustrated with photographs and engineering drawings. Hauck Mfg. Co., 124-136 Tenth St., Brooklyn 15, N. Y.

Circle No. **22** *on Reply Card*

Commercially Prepared Waxes

Synthetic Waxes by Glyco; 16-page booklet discussing chemical and physical properties of commercially made wax-like products; two types presented, those insoluble in water and those dispersible in water; uses and suggestions for waxes for use with petroleum products. Glyco Products Co. Inc., 26 Court St., Brooklyn 2, N. Y.

Circle No. **23** *on Reply Card*

Liquid Dispensing Pumps

Mauch Metering Pumps, Catalog 51A; 12 pages of construction and operational description of small, stainless steel pumps, variable in capacity, effective in dispensing viscous or non-viscous (hot or cold) liquids; illustrations, specifications, capacities included. Mechanical Products Corp., 168 N. Ogden Ave., Chicago 7, Ill.

Circle No. **24** *on Reply Card*

Exchanger for Corrosive Liquid

"Delanium" Carbon, Cubic Heat Exchanger; 14 pages describing the materials of construction, design information, and a partial table of corrosive materials which can be handled in a special carbon type exchanger; illustrated. British-American Carbon Corp., 18 East 48th St., New York 17.

Circle No. **25** *on Reply Card*

Refractories in Boiler Settings

Boiler Settings With Plastic and Castable Refractories; 24-page catalog and data booklet combined, discusses spall resistance, insulation, design and installational features of improved plastic and castable refractories, and their applications in modern boiler settings; cross-sectional drawings, charts, technical illustrations included. Ramtite Co., Div. of the S. Obermayer Co., 2563 West 18th St., Chicago 8, Ill.

Circle No. **26** *on Reply Card*

Thermocouple Glands

Conax Bare Wire Thermocouple Glands, Bulletin 951; four-pages discussing the advantages of using thermocouple glands as a means of sealing bare wires entering pressure or vacuum chambers, to obtain more accurate temperature measurements; details temperature and pressure limits and the principles of sealing glands with talc; specifications table included. Conax Corp., 1515 Main St., Buffalo 21, N. Y.

Circle No. **27** *on Reply Card*

Electronic Control

Electronic Transmission and Control. Data release A-703; six-page illustrated brochure explains the "Autronic" principle and how it is incorporated into a control system that utilizes electronics for automatically measuring and controlling process variables; a system circuit diagram

NOW... More Than Ever...
PROTECT YOUR TANKS!

Shortages of steel, for new tankage and repair of old, necessitates your making every tank last as long as possible.

NATASCO protective coatings prevent corrosion damage of new tanks and provide many additional years of service from old ones.

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Lease Tank Service—West Texas Area:
Williams Construction Co.
Odessa, Texas

California Representative
Coast Contractors, Inc.
2627 Atlantic Ave., Long Beach 6, Calif.

(To obtain more data on advertised products see page 218)

is included with a discussion of a typical application. Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.
Circle No. 28 on Reply Card

Chemical Catalog

Baker & Adamson, Laboratory Reagents and Fine Chemicals; 264-page catalog of approximately 1000 chemical products, from small bottle lots of laboratory reagents to carload quantities of fine chemicals for exacting industrial uses; conversion factor tables and international atomic weights included. General Chemical Division, Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.
Circle No. 29 on Reply Card

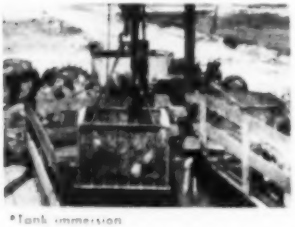
Surface Active Esters

Esters by Glyco; 24-page brochure contains tables of physical and chemical specifications of the non-ionic polyhydric alcohol fatty acid esters; data are listed for such applications as surface active agents, emulsifiers, stabilizers, defoamers, penetrants and plasticizers. Glyco Products Co. Inc., 26 Court St., Brooklyn 2, N. Y.
Circle No. 30 on Reply Card

*TWO low-cost ways to make salvage pay

Either way—tank immersion or steam-detergent cleaning—you save money when you reclaim used parts with job-designed Oakite cleaning and derusting materials. You speed up disassembly, inspection and repair. You save the expense of purchasing new parts . . . save time restoring old parts to condition.

Here's what you get with



*Tank immersion

Tank immersion: Heavy-duty, long-lasting Oakite solution quickly removes grease, caked-on oil, waxy deposits. Excellent for degreasing piping, well tools, pump engines, motor parts, valves, etc. Tank also adaptable to cold solution cleaning with Oakite solvent-emulsion cleaners . . . derusting with specialized Oakite compounds.

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Steam-detergent cleaning: Speedy cleaning of parts too large for solution tank. Removal of heavy, semi-loose deposits before tank-cleaning. Reduces boiling out time, insures longer solution life. Tops for cleaning when equipment urgently needed for production.

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OAKITE PRODUCTS, INC., 48 Thames St., NEW YORK 6, N. Y.
Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE

PETROLEUM SERVICE DIVISION

Octane Improvements

Mechanical Octane Numbers, by Earl Bartholomew; 14-page brochure defining mechanical octane numbers with comparisons of performances of a 1950 engine to a 1939 engine; research on combustion and combustion chamber design, advantages and disadvantages of supplementary fuel devices; improvements in fuels. Ethyl Corp., 100 Park Ave. Bldg., Park Ave. at 41st St., New York 17, N. Y.
Circle No. 31 on Reply Card

Flow Meters

Stock Flow Meter Program, Pub. 10529; eight-page folder describing a newly-developed metering float for "area" flow rate meters and indicators with true percentage flow scales and factor tags; specifications, capacities, sizes, dimensions, and prices supplied. Fischer & Porter Co., 5580 County Line Rd., Hatboro, Pa.
Circle No. 32 on Reply Card

Floors Built To Last

How to Build Corrosion-Resistant Floors, Bulletin AB-17; 16 pages describing materials of ocnstruction for corrosion-proof, brick floors, which can withstand acids, alkalies, oils, solvents, water, steam, and heavy traffic; section of typical questions and answers, illustrated. The U. S. Stoneware Co., Akron 9, Ohio.
Circle No. 33 on Reply Card

Refinery Welding Procedures

Arcomatic Welding Refinery Components and Pressure Vessels, by Stephen A. Yaczko, Form ADR 76; eight-page reprint from *The Welding Journal* describes procedures for welding stainless, stainless clad steel, low-alloy steel and copper-alloy pressure vessels with the inert-gas-shielded metal-arc process; supplemented with application photographs and sketches of plate preparation. Airco Reduction Sales Co., 60 East 42nd St., New York 17, N. Y.
Circle No. 34 on Reply Card

Petroleum Processing Index

PETROLEUM PROCESSING *Index for 1951;* includes subject and author indexes for all feature articles and regular departments for the 12 issues of this magazine published during 1951. Platt's Petroleum Publications, 1213 West 3rd St., Cleveland 13, Ohio.
Circle No. 35 on Reply Card

Small Flows Visually Inspected

Brooks Mite Purge Meters, Bulletin No. 120; six-page leaflet describing instruments which indicate small gas and liquid flows; illustrated with photographs, engineering drawings and capacity tables. Brooks Rotameter Co., Lansdale, Pa.
Circle No. 36 on Reply Card

Combustion Gases Measured

Hays Condu-Therm CO$_2$ Recorder, Bulletin 51-1008; 12-page booklet discusses gas sampling systems with reference to the operation of the analyzing and recording sections in a CO_2 recording instrument, which employs the thermal conductivity principle, and is capable of measuring concentrations of other gases. The Hays Corp., Michigan City, Ind.

Circle No. **37** *on Reply Card*

Save Money with Fine Wire

Separation with York Elements, Bulletin 11; eight pages describing the use of technical knitted wire mesh for entrainment separation, mist extraction, gas filtering, tower packing, cleaning, and baffling, indicating ways to save money using this material in petroleum and chemical processing. Otto H. York Co., Inc., 364 Glenwood Ave., East Orange, N. J.

Circle No. **38** *on Reply Card*

Chemical-resistant Fabric

M. S. A. ChemKlos, Work Clothes That Last and Last, Bulletin No. CF-28; four-page folder telling of DYNEL, a chemically resistant fabric of tight, light-weave, to lengthen the life of work shirts, trousers and coveralls; sample attached. Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh 8, Pa.

Circle No. **39** *on Reply Card*

Fire Fighting Equipment

Rockwood Fire Fighting Products, Portable Catalog CP-7-50M-51; 12-pages describing latest fire fighting equipment and chemicals, foam and fog, well illustrated with technical data. Rockwood Sprinkler Co., 58 Harlow St., Worcester 5, Mass.

Circle No. **40** *on Reply Card*

Tubing Products and Applications

Uniform Tubes; four-page catalog covering a complete line of fine seamless tubing used as component parts of precision equipment and machinery, available in sizes from 0.010 in. O.D. to $\frac{5}{8}$ in. O.D. and in metals of various alloys; specialty "pointer" tubing description, illustrations, and general specifications included. Uniform Tubes, Collegeville 2, Pa.

Circle No. **41** *on Reply Card*

Centrifugal Pumps

Worthington Centrifugal Pumps, Bulletin W-341-B2C; 12-page booklet discusses single-stage HR and two stage HB centrifugal pumps for refinery service regarding design, bearing assembly, cooling system, etc.; gives standardized materials of construction, and engineering dimensions. Worthington Pump and Machinery Corp., Harrison, N. J.

Circle No. **42** *on Reply Card*

Versatile Trucks

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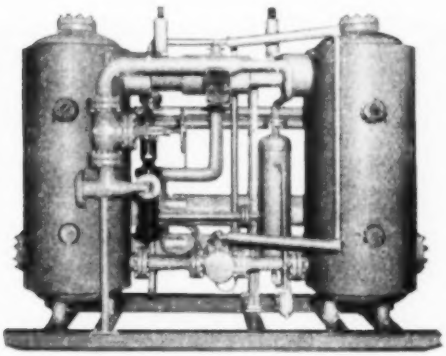

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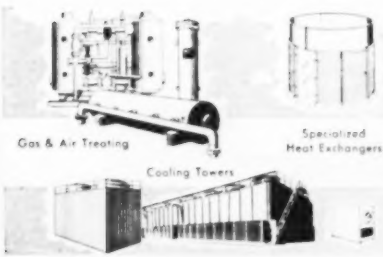

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Literature Offered in this Issue's Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature offered in this issue:

ACTIVATED ALUMINA: Information offered by Aluminum Co. of America. See adv't p. 159.

ADDITIVES: for lube oils, viscosity index improver type. Details offered by Monsanto Chemical Co. See adv't p. 153.

ALLOYS: tanks. Booklet "Haynes Wrought Alloys" offered by Haynes Stellite Co. See adv't p. 153.

BLENDERS: continuous automatic. Literature offered by Proportioners, Inc. See adv't inside front cover.

BLOWERS: axial flow. Data offered by Read Standard Corp. See adv't p. 238.

CATALYST: level measurement. Bulletin No. 110 offered by Instruments, Inc. See adv't p. 202.

CAT-CRACKERS: Fluid & Thermofor types. Bulletin CF2/51 offered by The Fluor Corp. See adv't p. 212.

CLEANING & DERUSTING: Booklet F762S offered by Oakite Products, Inc. See adv't p. 236.

COMPRESSORS: automatic controls for. Catalog 400 offered by Taylor Instrument Companies. See adv't p. 165.

COOLING TOWERS: Bulletins offered by J. F. Pritchard & Co. See adv't p. 225.

CORROSION INHIBITORS: Technical paper No. 123 offered by W. H. & L. D. Betz. See adv't p. 145.

CYCLOVERSION: information offered by Phillips Petroleum Co. See adv't p. 244.

DATA ANALYSIS: automatic. Brochure & specifications offered by Telecomputing Corp. See adv't p. 200.

DRIER UNITS: for gas and air. Bulletin No. 56-0 offered by J. F. Pritchard & Co. See adv't p. 257.

FILTERS: liquid. Bulletin D-11 offered by Dollinger Corp. See adv't p. 124.

FITTINGS: pipe, welded. Catalog No. W-3 offered by Bonney Forge & Tool Works. See adv't p. 228.

FRACTIONATOR TRAYS: Information offered by Koch Engineering Co., Inc. See adv't p. 156.

GAUGES: liquid level. Catalog 35 offered by Penberthy Injector Co. See adv't p. 260.

GAUGES: liquid level, for high pressure and temperatures. Catalog 31 offered by Penberthy Injector Co. See adv't p. 260.

GAGES: liquid level, heated. Data offered by Jerguson Gage & Valve Co. See adv't p. 213.

GOVERNORS: standardized. Type E Turbine Book 49027 offered by Westinghouse Electric Corp. See adv't p. 228.

HEAT EXCHANGERS: sectional, copper. Bulletin No. 141 offered by The Brown Fintube Co. See adv't p. 161.

MIST ELIMINATORS: 3-stage, tubular. Offered by Metal Textile Corp. See adv't p. 224.

MIXING EQUIPMENT: side entering. Catalog No. 400 offered by Eastern Industries, Inc. See adv't p. 218.

MOTOR SELECTION & APPLICATION COURSE: Bulletin GEA 4928.16 offered by General Electric Co. See adv't pp. 172-173.

PACKING: sealing boxes, saddle-type. Technical data and samples offered by U. S. Stoneware Co. See adv't p. 232.

PAINTING CONTRACT SERVICE: Information offered by The Nelsaco Co. See adv't p. 253.

PAINT, heavy-duty for tanks: Information offered by The Sherwin-Williams Co. See adv't p. 147.

PROCESS ENGINEERING: sulfur recovery, sweetening, cracking, gas converters and generators: Literature offered by General Industrial Development Corp. See adv't p. 258.

PUMPS: controlled volume: Information offered by Milton Roy Co. See adv't p. 208.

PUMPS: jet ejector: Bulletin 512 offered by Penberthy Injector Co. See adv't p. 260.

PUMPS: rotating plunger type, for asphalt: Bulletin 148 offered by Kinney Mfg. Co. See adv't p. 205.

PUMPS: sump: Bulletin 4829 offered by Penberthy Injector Co. See adv't p. 260.

PURIFIERS: for steam, gases, vapors etc.: Bulletins 2100, 200, the 400, 500 offered by The V. D. Anderson Co. See adv't p. 222.

RADIUM: Safety Code: offered by Isotopes, Inc. See adv't p. 252.

RUST PREVENTIVE: Literature offered by Rust-Oleum Corp. See adv't p. 239.

SEALS: leak-proof O-ring: Catalog 5100 offered by Parker Appliance Co. See adv't p. 228.

STEAM TRAPS: Catalog 751 offered by W. H. Nicholson & Co. See adv't p. 237.

THERMOMETERS: Catalog G-113-B offered by The Electric Auto-Lite Co. See adv't p. 219.

THERMOSTATIC SWITCH: multi-purpose. Catalog No. 400 offered by Fenwal, Inc. See adv't p. 157.

TUBE ROLLERS: for condensers, heaters etc.: Information offered by The Gustave Wiedeke Co. See adv't p. 218.

TUBES & PLATES: for condensers & heat exchangers: Publication B-2 offered by The American Brass Co. See adv't p. 151.

VALVES: control. Catalog 1000B offered by The Conco Co. See adv't p. 261.

VALVES: control. Bulletin 277.2 offered by The Foxboro Co. See adv't p. 199.

VALVES: diaphragm-motor. Bulletin 700-3 offered by Minneapolis-Honeywell Regulator Co. See adv't p. 217.

VALVES: gate. Catalog offered by Crane Co. See adv't p. 154.

VALVE OPERATOR: semi-steam pneumatic. Bulletin 51 offered by Chapman Corp. See adv't p. 257.

VALVES: refinery specifications. Booklet offered by The Hancock Mfg. Co. See adv't pp. 178-179.

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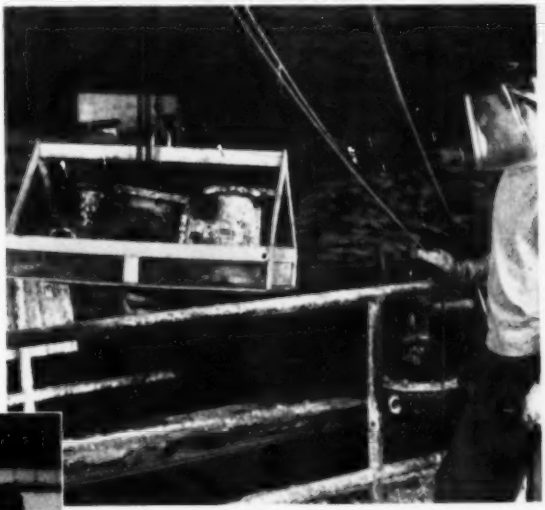
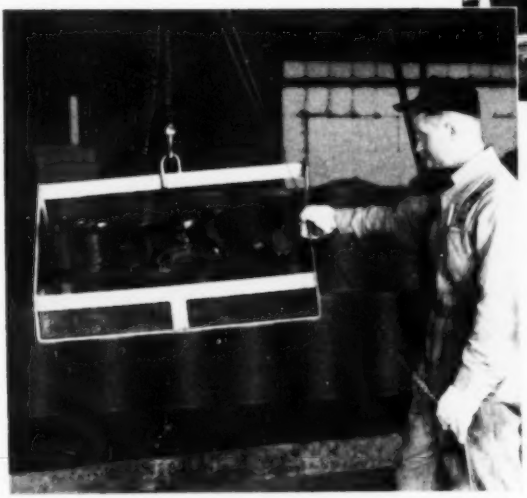


Steel fittings before Virgo Molten Cleaner Treatment



Same fittings after final rinse

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You can salvage thousands of dollars' worth of used chemical equipment quickly and at low cost, with Virgo Molten Cleaner. It removes paint, dirt, rust and chemical impurities—gives you a clean surface in 10 to 15 minutes. No hand scraping, brushing, tumbling or sand blasting are needed.

Virgo Molten Cleaner may be used on any metal not seriously affected by molten caustic. The process is simple and inexpensive. Here are its main steps:

1. Dip in Virgo Molten Cleaner Bath at 850° F—5 to 15 minutes.
2. Water quench.
3. Acid dip. 2 to 5 minutes.
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Valves	Pipe	Tanks
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and hundreds of other salvageable items

★ *QUICKLY REMOVES:*

Grease	Rubber	Atmospheric Corrosion
Paint	Enamel	Chemicals
Dirt	Glass	

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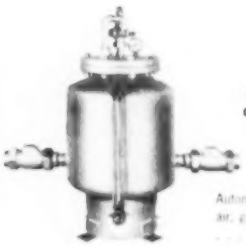
YOU CAN *Remove and Replace Without Shutdown*

Union connections between the gage and the valves permit removal of gage for repairs without shutting down the equipment. Just close the valves, uncouple the unions and remove the gage. The convenience of this is obvious. When glasses have to be replaced or repairs made, it is not necessary to work in an awkward position or to shut down. Another advantage: a gage needing repairs can be replaced immediately by a spare and the repairs made at leisure. There are many other reasons for the superiority of Penberthy Liquid Level Gages; ask for Catalog 35.

OTHER PENBERTHY PRODUCTS

PENBERTHY TRANSPARENT GAGE

Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal. Ask for Catalog 25.



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Automatically operated by air, gas or steam pressure . . . Will pump without clogging any liquid that will flow through pipes. Ask for Bulletin 5030.

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A simple jet pump operated by air, water or steam. Needs no lubrication . . . will not get out of order. Made in wide variety of materials and special units developed to meet unusual conditions. Ask for Bulletin 512.

PENBERTHY EXPLOSION-PROOF SUMP PUMPS

Motor and switch totally enclosed. Underwriter approved for Class 1, Group D, and Class 2, Groups E, F, and G hazardous location. Made of copper and bronze throughout. Ask for Bulletin 4329.

4672

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DIVISION OF THE BUFFALO-ECLIPSE CORPORATION

DETROIT 2, MICHIGAN

Established 1886 — *Canadian Plant, Windsor, Ontario*

Refineries' Personnel Merit API Safety Awards

Nine top supervisors of the Engineering-Construction Department of General Petroleum Corp. congratulate each other on receiving two "Million Hour" accident prevention awards from the American Petroleum Institute. The men are (left to right): **F. P. Lennon**, Vernon superintendent; **S. M. Lyon, T. J. Sullivan, L. H. Fosburg, John Tipps, A. H. Sievi, J. T. Rothenberger, Elmer Hayes**, and **B. C. McCoy**, Torrance superintendent.

Chalmer G. Kirkbride has been elected president of the Houdry Process Corp. and **Dr. Claude C. Peavy** vice chairman of the Board. **Clarence H. Thayer**, vice president of manufacturing, Sun Oil Co., has been elected as a member of the Houdry Board.

Mr. Kirkbride

Mr. Kirkbride was formerly vice president in charge of research and development and Dr. Peavy vice president in charge of engineering and sales. Members of the same graduating class at the University of Michigan in 1930, both joined Houdry in 1946.

Dr. Peavy

After leaving college, Mr. Kirkbride joined the Standard Oil Co. (Ind.) as a chemical engineer in the research department. He later served with Pan American Refining Corp. as assistant director of research, and with Magnolia Petroleum Co. as chief of chemical engineering development.

Dr. Peavy started his engineering career with E. B. Badger & Son, a construction firm. Later, he served as chief process engineer for the Socony-Vacuum Oil Co. Dr. Peavy joined Houdry as chief of the process design division in 1946 and a year later was appointed chief engineer. He has been vice president in charge of engineering and sales since 1948.

* * *

W. H. Hall and **R. E. Fluke** of the safety committee of The Texas Co.'s technical service and research laboratory at Signal Hill, Calif., received the company's safety award pennant in behalf of a staff of 37, who recorded over 250,000 man-hours without a lost-time accident.

* * *

Ben G. Symon, manager of Shell Oil Co.'s lubricants department, has been elected chairman of the lubrication committee of the American Petroleum Institute. He is a past president of the National Lubricating Grease Institute and has been with Shell for 23 years.

* * *

Mr. J. W. Morgan has been appointed as manager of British American Oil Co.'s, Montreal East refinery. He succeeds the late **Mr. R. F. A. Smith**. A graduate of the University of Alberta in chemical engineering, Mr. Morgan joined the company in 1939 at its Calgary refinery. He became administrative assistant to the manager of manufacturing in 1949, after holding several positions in the department. Last year he was appointed assistant manager of the company's Moose Jaw plant. For the past six months, Mr. Morgan has been on specific assignments in Washington, D. C., with the Petroleum Division, Department of Defense Production.

* * *

Norman T. Robey was assigned, on December 1st, as an additional assistant general superintendent to the Casper, Wyo. refinery of Standard Oil Co. (Indiana). He comes from Indiana Standard's Wood River, Ill. refinery, where he was assistant superintendent of the heavy oils division.

* * *

Harry L. Pelzer has been elected a director of Sinclair Research Laboratories, Inc. At present he holds the position of manager of the research facilities in Harvey, Ill.

* * *

G. R. Monkhouse, western division general manager of Shell Chemical Corp., has been elected vice president of the division. Offices will remain in San Francisco.

* * *

W. J. Tancig has been advanced to assistant chief chemist at the Whiting refinery of the Standard Oil Co. (Ind.), succeeding **Dr. J. C. Bailie**, who has been promoted to chief chemist at the company's Neodesha, Kans., refinery.

Mr. Tancig

Mr. Tancig joined Indiana Standard in 1939 as a chemist, served five years in the army during World War II, and was named group leader on the research staff at Whiting in 1946. He holds bachelor's and master's degrees in science from the University of Chicago, and is a member of the American Chemical Society.

Dr. Bailie, who has been assistant chief chemist at Whiting since 1947, succeeds **H. V. Knight**, who has been transferred to the manufacturing department at Neodesha. A graduate in chemical engineering from the University of Illinois in 1933, Dr. Bailie received his master's degree in chemistry from Kansas State Teachers College in 1934. He joined the company as a chemist in 1938 after receiving his doctorate from Iowa State College.

* * *

Five employees of the Bayonne, N. J., refinery, Tide Water Associated Oil Company, have received promo-

Why Most Leading Companies Are Using K & M Control Valves

It is logical that leading companies should handle the important subject of control valves as they do other matters: They make use of the best available skills and thinking. More and more, they utilize the equipment, knowledge and facilities of the K & M engineering and service team.

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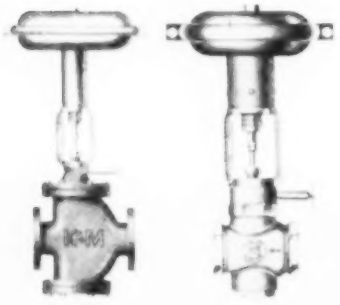
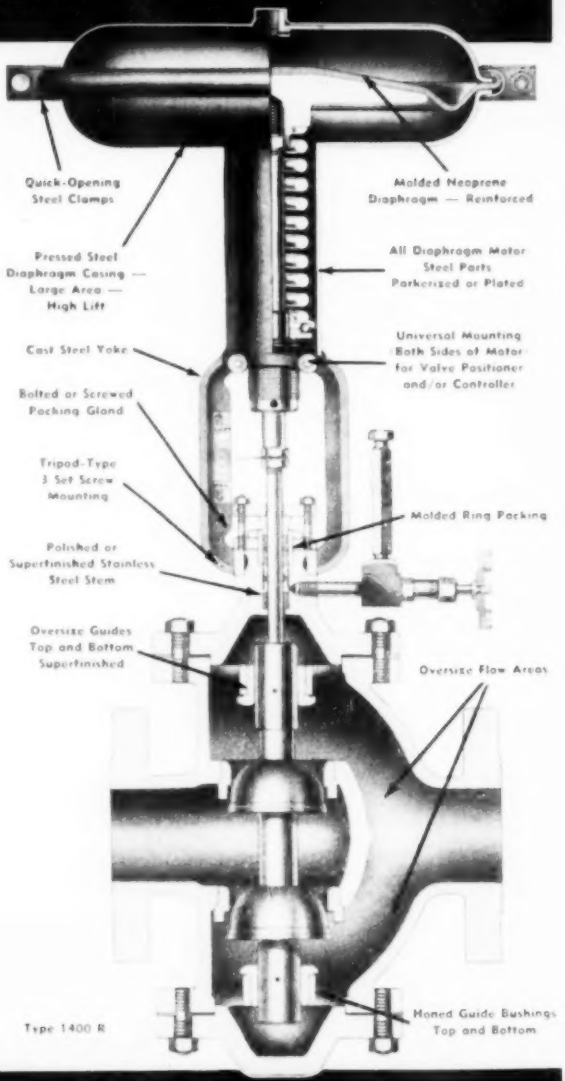


Type 1200 Type 1000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tions. They are: **Everett T. Chandler**, to assistant general foreman of the machine shop; **Raymond H. Freckmann**, to assistant supervisor of the package and shipping department; **Laurance A. Gleason**, to technical assistant to the general superintendent; **Stanley A. Rader**, to assistant foreman of the bulk pumping department; and **Francis Stephens**, to foreman of the salvage shop.

* * *

Herman E. Ries, Jr., has recently been appointed research associate in the Whiting research laboratories of Standard Oil Co. (Ind.). Dr. Ries received his Ph.D. in chemistry from the University of Chicago and has been associated with the Sinclair Refining Co. for the past fifteen years.

* * *

Cecil Morgan, vice president, of Esso Standard Oil Co., Baton Rouge, La., has been elected to the company's board of directors, with offices at the New York headquarters.

Henry J. Voorhies, general manager, has been elected to succeed Mr. Morgan as vice president of the Louisiana division in charge of manufacturing, public relations and crude oil purchasing operations. He will continue as general manager of the Baton Rouge refinery.

* * *

L. R. Gray has been appointed chief technologist at the Shell Oil Co. refinery at Martinez, Calif.

A University of Chicago graduate, Mr. Gray began his career as assistant chief chemist at the Arkansas City refinery in 1925, later serving at the Houston and Wood River refineries. In 1941, he was transferred to the New York head office as assistant manager of the manufacturing research and development department. He returned to the Wood River refinery later that year as chief technologist.

* * *

Fred B. Behrens, manager of manufacturing for the Wilshire Oil Co., has been appointed vice president.

Mr. Behrens was graduated from the University of Wisconsin in 1928, worked for Universal Oil Products Co. until 1936 when he joined Wilshire Oil as treating superintendent. He became manager of manufacturing in 1945.

* * *

T. W. Nelson has been appointed associate director of the Socony-Vacuum Oil Co. with headquarters in New York City. The appointment is effective March 1st. He is to coordinate research conducted in laboratories at Paulsboro, N. J., Brooklyn, N. Y., and Dallas.

* * *

W. B. Strobel, senior chemical engineer in the process division of Continental Oil Co.'s manufacturing department, has been promoted to the newly-created position of technical assistant to the manager of the petrochemical department.

Mr. Strobel will move from Ponca City to Houston, where he will make his headquarters.

Born in Kansas City, Kan., Mr. Strobel is a graduate of the University of Colorado, where he also received his M. S. degree in chemical engineering. He joined Continental Oil Co. in Ponca City in 1948 as a chemical engineer, became senior chemical engineer in 1950, and in May, 1951, was promoted to senior chemical engineer, process division.

* * *

R. Chester Reed of The Texas Co., New York City, has been appointed chairman of the program committee for the Fourteenth Annual Forum of the Packaging Institute to be held at Hotel Commodore in New York City on October 20-22, 1952.

* * *

M. H. Arveson, technical director of the Indoil Chemical Co., a subsidiary of the Standard Oil Co. (Ind.), has been elected to a four-year term as director-at-large of the American Chemical Society.

* * *

Joseph F. Wood, chief chemist of Skelly Oil Co.'s natural gasoline division, has been promoted to superintendent of the research laboratory facilities, now being reorganized at Pawhuska, Okla. Mr. Wood, who has been with the company for the past 15 years, is a graduate of Oklahoma A & M College.

* * *

William T. Dixon, Atlantic Refining Co., Philadelphia, is one of five new directors recently elected by the American Institute of Chemical Engineers; he will serve a one-year term. Mr. Dixon is manager of the design division, engineering and construction department, for Atlantic, and has been with the company since 1927. He is a graduate of M.I.T.

* * *

Irving E. Miller, chemical engineer in the Standard Oil Co. (Ind.) research laboratory at Sugar Creek, Mo., has been promoted to group leader. Mr. Miller joined Standard in 1944. He is a graduate of the University of Kansas.

* * *

Marion V. Long, staff consultant in Shell Development Co.'s instrumentation department at Emeryville, Calif., has been named head of the mechanical and electrical engineering department.

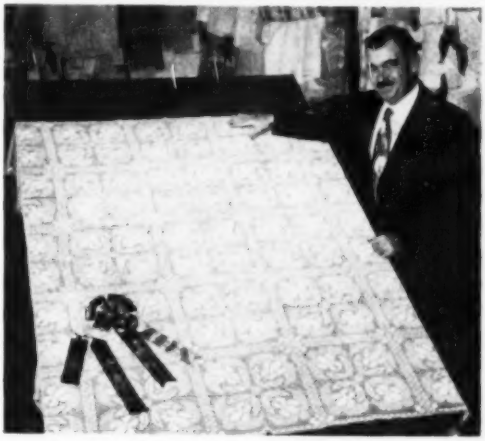
* * *

F. E. Caddy, former superintendent of Shell Chemical Corp.'s Houston, Texas plant, has been named manager of Shell Chemical's Martinez, Calif. plant, succeeding **O. M. Williams**, now assistant to vice president in charge of manufacturing, N. Y.

R. W. McOmie, manager of Shell Oil's Dominguez refinery (Los Angeles), has been given a special assignment in the company's manufacturing department in New York. During Mr. McOmie's several months' absence, **S. J. Meisenburg** will be acting manager at Dominguez.

A graduate of Stanford University, Mr. Caddy joined Shell Chemical in 1931 as a laboratory assistant. Later he held various technical and administrative posts in chemical manufacturing at Dominguez and Torrance, Calif., becoming senior technologist in Shell Chemical's San Francisco office in 1947. He was made superintendent of the Houston plant in 1948.

Refinery Foreman Wins Contest



George Link, foreman in the stills of the Wood River, Ill., refinery of Standard Oil Co. (Ind.), displays his first-place, prize winning crocheted tablecloth, which won championship honors for him as best male crocheter in the Nationwide Crochet Contest. Mr. Link's award consisted of $100, an engraved trophy and an all-expense visit in Chicago.

EDITORIAL VIEWPOINTS

Opinions and Comments on Current Topics

The Same Tune, Different Words

AN executive of a mining company recently stated publicly: "Many of the studies put out by the Bureau of Mines and others over recent years, which give the impression there are only 10 to 15 years more lead supply in the U. S., are most misleading to the public. Experienced mining men know that such statements are wrong, but in the absence of definite ore reserve figures it is hard to prove to the public . . . . The next time you see a frightening headline about the exhaustion of our raw mineral resources, pass it by."

This theme is most familiar to petroleum industry men. From even the early days of the industry government agencies, lately the Bureau of Mines, have been prophesying the number of years before our petroleum supplies would play out.

Is it a practice of the Bureau to forecast disaster, in the belief this is needed to hold public support for its growing activities in the petroleum and minerals field?

—V.B.G.

The Eclipse of Industrial Research

THE figures in the President's latest budget message to Congress stating the large sums the government is devoting to research and development emphasize the growing danger to industry in this country of being thrust far into the background as a sponsor and promoter of research. Truman's message estimates the research funds needed by the Department of Defense alone for 1953 at $1,400,000,000, an increase of $400,000,000 over 1952. Huge as this sum is it by no means includes all the federal funds being spent on work to which more and more of the nation's scientists are being assigned.

Compare this estimate for government spending for research with the $100,000,000 or a little more which the petroleum industry now spends annually for this purpose. Petroleum is one of the leading industries in this country in research expenditures and the total for all industry would not be more than a few hundred millions annually.

While a good part of the Defense Department funds are spent on highly specialized atomic energy and similar isolated projects, the impact of the government's programs on industrial research still is making itself felt in several ways, and with increasing severity. Scientific manpower is being drawn off from the schools and from industrial firms. Rates of pay for scientists in government service have been upgraded so they are now in line with what private concerns can pay. In addition, the government offers transportation and even housing on some of its projects and other inducements which are not general industry practice.

More and more government research work is being assigned to oil company and other industrial laboratories under conditions which the companies can hardly refuse to accept. The work of the trained personnel and supervisors given over to such work has to be taken off the companies' own program. Also, oil and other industry professional men are called on to give increasingly of their time to committee and group work which is tied in with government research projects and which takes them away from their own work.

The shadow of the large sums now being spent and available in the future for government research has fallen over the scientific schools of the country. The work the oil companies and other industries carry on here as part of their research programs, through fellowships and grants and direct projects, in many cases has become of less importance in the eyes of the educators and school administrators in view of what the government is spending.

Under the mushrooming defense effort, it hardly can be otherwise than that industrial research will for a time be eclipsed by the magnitude of the government's program. To make the eclipse as brief as possible and to lessen the impact on its own research is an objective to which management of the petroleum and other industries should give immediate attention.

—V.B.G.

Oil and Automotive Liaison

THE broad approach to the technological problems of the automotive industry which the Society of Automotive Engineers has consistently maintained is reflected in the election as SAE president for 1952 of a petroleum industry man, Dr. Daniel P. Barnard IV, research coordinator for Standard Oil Co. (Indiana). Only four years ago, another oil company man, R. J. S. Pigott, of Gulf Research & Development Co. served as head of the Society.

The problems of the designers of cars and engines and other automotive equipment and of the oil companies which supply their fuels and lubricants have always been closely related. As performance is improved, through higher compression engines and other new features, the service requirements on fuels and lubricants have become increasingly severe, and the end of this road is not in sight. Close cooperation and mutual understanding within the two industries is essential, to avoid placing undue economic burdens on owners and operators as compression ratios are further advanced and other performance improvements made.

Dr. Barnard brings unusual ability, training and experience to his new position. He has been a director of the Coordinating Research Council, sponsored jointly by the SAE and API, since its incorporation and he was president in 1948, '49 and '50. His qualifications can be summed up no better than in the words of the SAE Horning Memorial Award given him in 1949, "distinguished active service in the field of mutual adaptation of fuels and engines."

—V.B.G.

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Sodium Tripolyphosphate
ANHYDROUS

$Na_5P_3O_{10}$

Tetrasodium Pyrophosphate
ANHYDROUS (TSPP) (Pyro)

$Na_4P_2O_7$

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For Many Purposes

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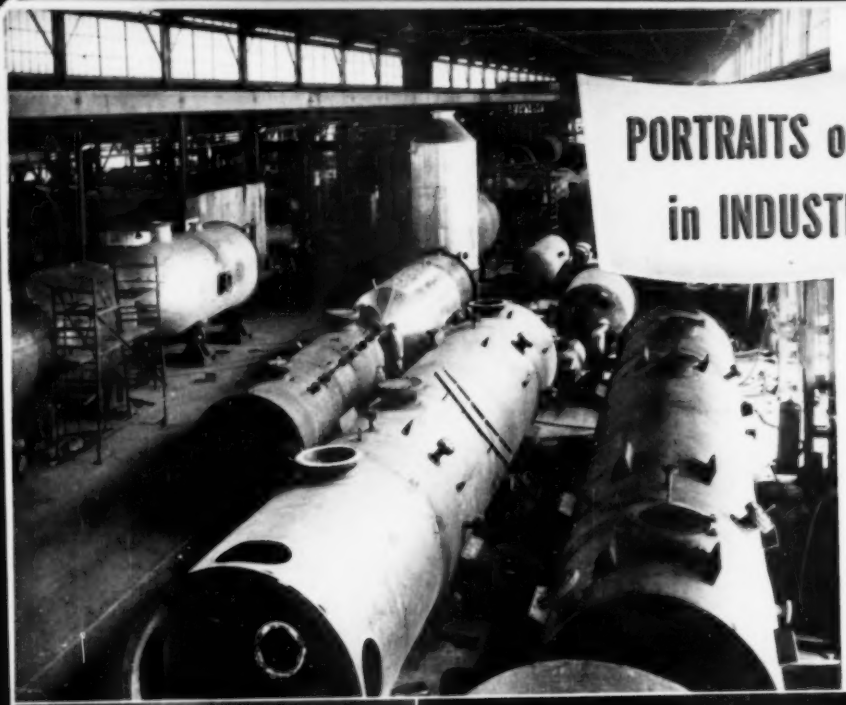

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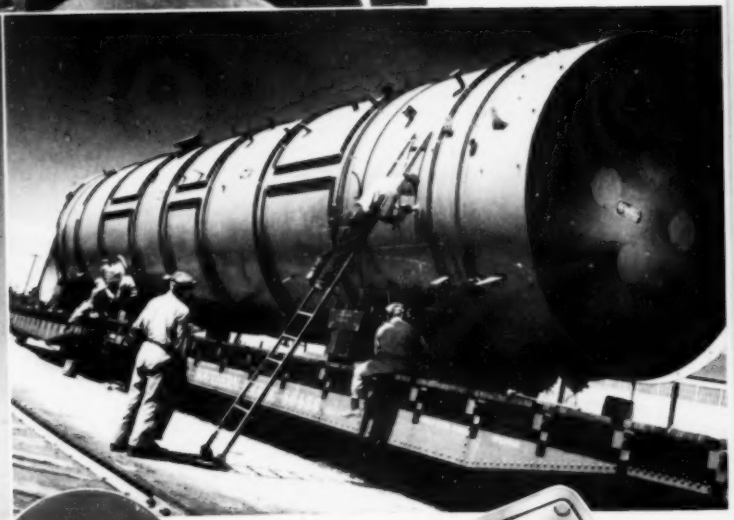

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